File No.

Bharath UNIVERSITY

பாரத் பல்கலைக்கழகம்

Declared under Section 3 of UGC Act, 1956

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COURSE FILE : 2018 - 2019 (SEM II)

COURSE NAME : WAVE OPTICS AND SEMICONDUCTOR PHYSICS LAB

COURSE CODE : U18BSPH2L2

Bharath
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
(Declared as Deemed - to - be - University under section 3 of UGC Act 1956)

COURSE FILE

NAME OF THE FACULTY	**Ms. R. SUGANYA**	**FACULTY DEPT**	**PHYSICS**
COURSE	**Wave Optics and Semiconductor Physics Lab**	**COURSECODE**	**U18BSPH2L2**
YEAR	**2018 - 2019**	**SEMESTER**	**II**
DEG & BRANCH	**B.TECH. (All branches)**	**DURATION**	

SL.NO	**DETAILS IN COURSE FILE**	**REMARKS**
1.	LESSON PLAN WITH CO MAPPING	✓
2.	SYLLABUS WITH COURSE OUTCOMES	✓
3.	MODEL EXAM - QUESTION PAPER	✓
4.	MODEL EXAM – SAMPLE ANSWER SHEET	✓
5.	LAB MANUAL	✓
6.	LAB OBSERVATION NOTE	✓
7.	RECORD NOTE	✓
8.	CO ATTAINMENT	✓

STAFF **HOD**

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(Declared as Deemed to be University ... of UGC Act 1956)
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U18BSPH2L2	**WAVE OPTICS AND SEMI CONDUCTOR PHYSICS LABORATORY** **(Common to B.Tech-EEE, ECE, EIE, BME, CSE & IT)**	**L**	**T**	**P**	**C**
	Total contact hours - 45	**0**	**0**	**3**	**2**
	Prerequisite: +2				
	Course offered by – Department of Physics				
	Data Book/Codes /Standards : Higher Secondary				

COURSE OUTCOMES(COs)	
CO1	Demonstrate the concept of optics (Manipulation)
CO2	Understand the principles of laser in optical communication (Precision)
CO3	Achieve the principles of semiconductor (Precision)

Mapping of course outcomes with programme outcomes(POs)

(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	H	M		H						H		
	CO2	H	M		H						H		
	CO3	H	M		H						H		
3	Category	**Basics Sciences(BS)**											
4	**Approval**	47th Meeting of Academic Council held in Aug, 2018											

LIST OF EXPERIMENTS FOR SEMESTER I & II

1. Determination of wavelength of laser light
2. Determination of particle size using laser
3. Determination of acceptance angle of an optical fibre
4. Determination of thickness of a thin wire using air wedge method
5. Determination of velocity of sound and compressibility of liquid by using ultrasonic interferometer
6. Determination of specific resistance of the given wire using Carey Foster's Bridge
7. Determination of the wavelength mercury spectrum using grating
8. Determination of the band gap of semiconducting material
9. Determination of V - I characteristics of light dependent resistor
10. Determination of I – V characteristics of Zener diode

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BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

DEPARTMENT OF PHYSICS

LESSON PLAN

Wave Optics and Semiconductor Physics Lab – U18BSPH2L2

S. No	Date	Name of the Experiment
1	18.09.2018	Determination of wavelength of laser light
2	24.09.2018	Determination of particle size using laser
3	09.10.2018	Determination of acceptance angle of an optical fibre
4	02.02.2019	Determination of thickness of a thin wire using air wedge method
5	06.03.2019	Determination of velocity of sound and compressibility of liquid by using ultrasonic interferometer
6	13.03.2019	Determination of specific resistance of the given wire using Carey Foster's Bridge
7	20.03.2019	Determination of the wavelength mercury spectrum using grating
8	21.03.2019	Determination of the band gap of semiconducting material
9	22.03.2019	Determination of V - I characteristics of light dependent resistor
10	23.03.2019	Determination of I – V characteristics of Zener diode

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DEPARTMENT OF PHYSICS

MODEL EXAM – LIST OF QUESTIONS

Wave Optics and Semiconductor Physics Lab – U18BSPH2L2

1. Determination of wavelength of laser light
2. Determination of particle size using laser
3. Determination of acceptance angle of an optical fibre
4. Determination of thickness of a thin wire using air wedge method
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Name: S. K. Nizanth
Reg. No: U18EC016

Model Examination – Physics Lab.

Determination of Particle Size Using Laser.

Aim: To determine the Size of the given microparticles Present in the lycopodium Powder using laser light.

Apparatus: Laser Source, glass plate, Screen, Scale.

Formula: The Size of the given micro Particle is given by,

$$d = \frac{n \lambda D}{r} \text{ metre}$$

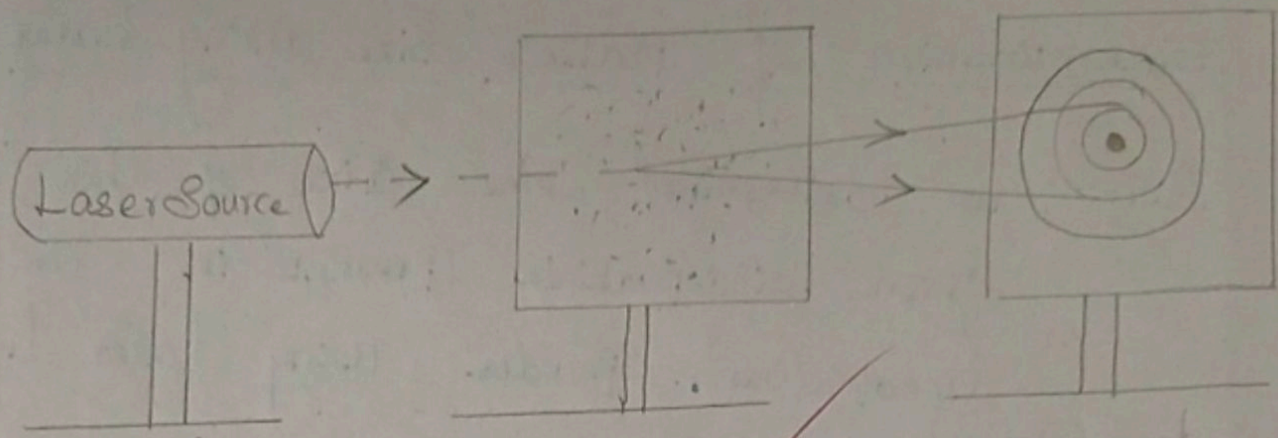
where

$n \rightarrow$ Order of rings

$\lambda \rightarrow$ Wavelength of the laser light

$D \rightarrow$ Distance btn Screen and glass plate

$r \rightarrow$ ~~Order~~ radius of the rings.



Sl. No	Distance between screen & glass	Order of rings	Diameter	Radius	$d = \frac{n\lambda D}{x_n}$
1.	10.5	1	20	10	7.245×10^{-6} m
		2	40	20	7.245×10^{-6} m
2.	17	1	30	1.5	7.82×10^{-6} m
		2	60	3	7.82×10^{-6} m

Mean $d = 7.532 \times 10^{-6}$ m

Calculation:

1. $d = 10.5 \times 10^{-2}$ m

$n = 1$

$x = 10 \times 10^{-2}$ m

$$d = \frac{n\lambda D}{x} = \frac{1 \times 6900 \times 10^{-10} \times 10.5 \times 10^{-2}}{10 \times 10^{-2}}$$

$$= 7.245 \times 10^{-6} \text{ m}$$

$n = 2$,

2. $$d = \frac{n\lambda D}{x} = \frac{2 \times 6900 \times 10^{-10} \times 10.5 \times 10^{-2}}{20 \times 10^{-2}}$$

$$= 7.245 \times 10^{-6} \text{ m}$$

3. $d = 17 \times 10^{-2}$ m

$n = 1$

$$d = \frac{1 \times 6900 \times 10^{-10} \times 17 \times 10^{-2}}{15 \times 10^{-2}}$$

$$= 7.82 \times 10^{-6} \text{ m}$$

4. $n = 2$, $$d = \frac{2 \times 6900 \times 10^{-10} \times 17 \times 10^{-2}}{30 \times 10^{-2}}$$

$$= 7.82 \times 10^{-6} \text{ m.}$$

Mean = 7.532×10^{-6} m.

Result:

The average Size of given Particle is

$= 7.532 \times 10^{-6}$ m or

7.532 μm.

Good

ENGINEERING

PHYSICS PRACTICALS

Common to all First Year B.E. / B.Tech Courses

PHYSICS LABORATORY MANUAL & OBSERVATION BOOK

GLOBAL PUBLISHING HOUSE

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V. Moulika
U18EC026

PREFACE

This book entitled "**Engineering physics practicals**" has been written in accordance with the latest syllabus prescribed by the Bharath University for the first year B.E/B.Tech students.

This book contains following two parts:

Measuring instruments (4 instruments)

First year experiments (8 experiments)

The measuring instruments will be more useful while performing some of the regular experiments. Each measuring instrument is well described and the working details for recording the readings of the instruments are clearly presented.

This book contains 8 experiments for the first year B.E / B.Tech students. All the experiments are discussed with neat diagrams, formulae, tabular columns and calculations. The contents of each experiment are systematically arranged and discussed in simple language so that the students can perform the experiments independently.

We hope this book will meet the requirement of the students to obtain practical skill in physics laboratory experiments.

We wish to thank the management of Bharath University for their moral support and encouragement to bring out this book successfully. We express our heartfelt thanks to the Publishers, **Global Publishing House**, Choolaimedu, Chennai for their neat and perfect execution of work to publish this book.

Suggestions are most welcome for the improvement of the book in the future editions.

Authors

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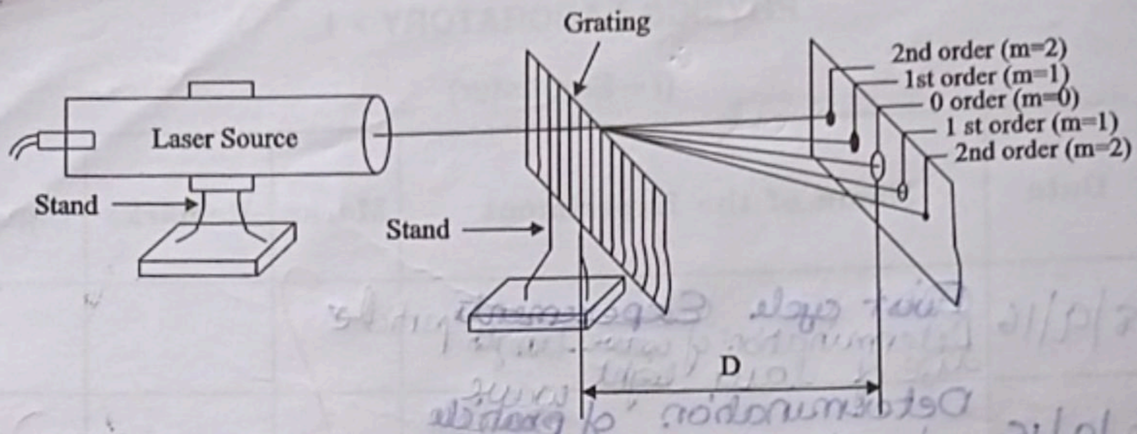


Fig. (a) Determination of wavelength (λ) of laser light - Laser grating

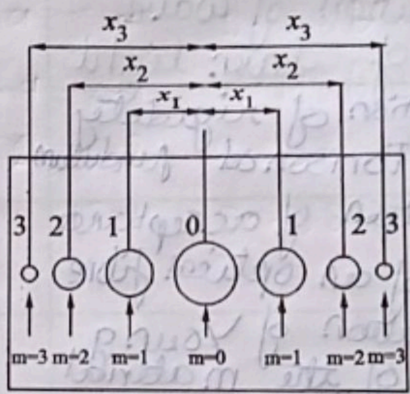


Fig. (b) Diffraction pattern

(i) Calculation of number of lines per metre (N) in the grating

Laser grating normally contains 2500 lines per inch.

$$1 \text{ inch} = 2.54 \text{ cm} = 2.54 \times 10^{-2} \text{ m}$$

$$2.54 \times 10^{-2} \text{ m contains } 2500 \text{ lines}$$

$$1 \text{ m contains } \frac{2500 \times 10^2}{2.54} = 98425 \text{ lines}$$

$$\boxed{\therefore N = 98425 \text{ lines/m}}$$

1. DETERMINATION OF WAVELENGTH OF LASER LIGHT

Expt. No:	1

Date:	18	09	2018

AIM

To determine the wavelength of the given laser light using grating.

APPARATUS REQUIRED

1. Laser light source
2. Grating
3. Screen
4. Half metre scale

FORMULA

The wavelength of the given laser light,

$$\lambda = \frac{\sin\,\theta}{Nm}\ \text{m}$$

EXPLANATION OF THE SYMBOLS

Symbol	Explanation	Unit
θ	Angle of diffraction	degree
m	Order of diffraction spots	
N	Number of lines per metre in the grating	lines/m

(ii) Determination of wavelength of laser light

Number of lines/m in the grating (N) = 10^5 lines/m

Distance between the grating and screen (D) = 45.5 cm

Sl. No.	Order of diffraction (m)	Distance of different spots from the central spot (x_m)			$\tan\theta = \frac{x_m}{D}$	$\theta = \tan^{-1}\frac{x_m}{D}$	$\lambda = \frac{\sin\theta}{Nm}$
		Left	Right	Mean			
Unit		cm	cm	cm		degree	m
1	1	2.9	2.9	2.9 (x_1)	0.0637	3.6448	6.355×10^{-7}
2	2	5.9	5.9	5.9 (x_2)	0.1296	7.3843	6.426×10^{-7}
3	3	8.9	8.9	8.9 (x_3)	0.1956	11.0673	6.396×10^{-7}
4	4	12.2	12.2	12.2 (x_4)	0.2681	15.0080	6.413×10^{-7}
5	5	15.4	15.4	15.4 (x_5)	0.3384	18.6958	$6 \times 4108 \times 10^{-7}$
6	6			3)			

Mean λ = 6.412×10^{-7} m

= 6412 $\times 10^{-10}$ m

= 6412 Å

PROCEDURE

The experimental set-up for the determination of the wavelength of the given laser light using grating is shown in Fig. (a). The laser source is kept horizontally. Extreme care should be taken to avoid direct exposure of eyes to laser light. The grating is held normal to the laser beam. A screen is placed on the other side of the grating.

Laser light source is switched on. For the normal incidence of laser beam on the grating, the position of the grating is adjusted such that the reflected laser beam from the grating coincides with the beam coming out of the laser source. Now, the diffraction pattern in the form of circular spots is observed on the screen. The diffraction pattern consists of central spot followed by a number of spots on either side of the central spot as shown in Fig. (b). The different spots on either side of the central spot are marked as the orders $m = 1, 2, 3,$ .... etc. The distances (x_m) of the different spots on either side from the central spot are measured using the scale. The distance between the grating and screen (D) is also measured.

The value of θ is calculated using the following expression,

$$\theta = \tan^{-1}\frac{x_m}{D}$$

and the wavelength of the given laser light is calculated using the formula,

$$\lambda = \frac{\sin\theta}{Nm}\ \text{m}$$

Result:

The Wavelength of the given laser light = 6412 A

(iii) Calculation

$N =$ 10⁵ lines/m, $D =$ 41 cm

1. For $m = 1$ and $x_m = x_1$ cm

$$\theta = \tan^{-1}\left(\frac{x_1}{D}\right) = 3.6276 \text{ degree}$$

$$\lambda = \frac{\sin\theta}{N \times 1} = 6.3276 \text{ m} = 6327.1 \times 10^{-10} \text{ m}$$

$$= 6327.1 \text{ Å}$$

2. For $m = 2$ and $x_m = x_2$ cm

$$\theta = \tan^{-1}\left(\frac{x_2}{D}\right) = 7.5026 \text{ degree}$$

$$\lambda = \frac{\sin\theta}{N \times 2} = 65285\times10^{-7} \text{ m} = 6528.5 \times 10^{-10} \text{ m}$$

$$= 6528.5 \text{ Å}$$

3. For $m = 3$ and $x_m = x_3$ cm

$$\theta = \tan^{-1}\left(\frac{x_3}{D}\right) = 11.2382 \text{ degree}$$

$$\lambda = \frac{\sin\theta}{N \times 3} = 64962\times10^{-7} \text{ m} = 6496.2 \times 10^{-10} \text{ m}$$

$$= 6496.2 \text{ Å}$$

4. For $m = 4$ and $x_m = x_4$ cm

$$\theta = \tan^{-1}\left(\frac{x_4}{D}\right) = 15.0134 \text{ degree}$$

$$\lambda = \frac{\sin\theta}{N \times 4} = 6.4761\times10^{-7} \text{ m} = 6476.1 \times 10^{-10} \text{ m}$$

$$= 6476.1 \text{ Å}$$

5. For $m = 5$ and $x_m = x_5$ cm

$$\theta = \tan^{-1}\left(\frac{x_5}{D}\right) = 18.9164 \text{ degree}$$

$$\lambda = \frac{\sin\theta}{N \times 5} = 6.4821\times10^{-7} \text{ m} = 6482.1 \times 10^{-10} \text{ m}$$

$$= 6482.1 \text{ Å}$$

6. For $m = 6$ and $x_m = x_6$ cm

$$\theta = \tan^{-1}\left(\frac{x_6}{D}\right) = 22.7580 \text{ degree}$$

$$\lambda = \frac{\sin\theta}{N \times 6} = 6.4473\times10^{-7} \text{ m} = 6447.3 \times 10^{-10} \text{ m}$$

$$= 6447.3 \text{ Å}$$

RESULT

The mean wavelength of the given laser light = ... Å

VIVA-VOCE QUESTIONS AND ANSWERS

1. What does the term LASER stand for?

LASER stands for Light Amplification by Stimulated Emission of Radiation.

2. What is stimulated emission?

The process of emission of photons due to external incident photons is called stimulated emission. The photon emitted due to stimulated emission has the same frequency and phase as those of the incident photon.

3. What are the characteristics of laser?

The laser beam has the following characteristics:

(i) High degree of coherence

(ii) High intensity

(iii) High directionality

(iv) High monochromaticity

4. Name any two industrial applications of laser beam.

(i) Laser beam can be used to make very small holes in hard materials like diamond, hard steel etc.

(ii) CO_2 lasers are used in welding thin sheets and foils without damaging the structure of the materials.

5. State grating formula.

The grating formula is stated as

$$(a+b)\sin\theta = n\lambda$$

$$\sin\theta = \left(\frac{1}{a+b}\right) n\lambda = N\,n\lambda$$

where $\frac{1}{(a+b)} = N =$ No. of lines per metre in the grating

$\theta =$ Angle of diffraction

$n =$ Order of spectra

and $\lambda =$ Wavelength of light used.

6. What is the number of lines per metre in the laser grating.

The number of lines per metre in the laser grating = 98425

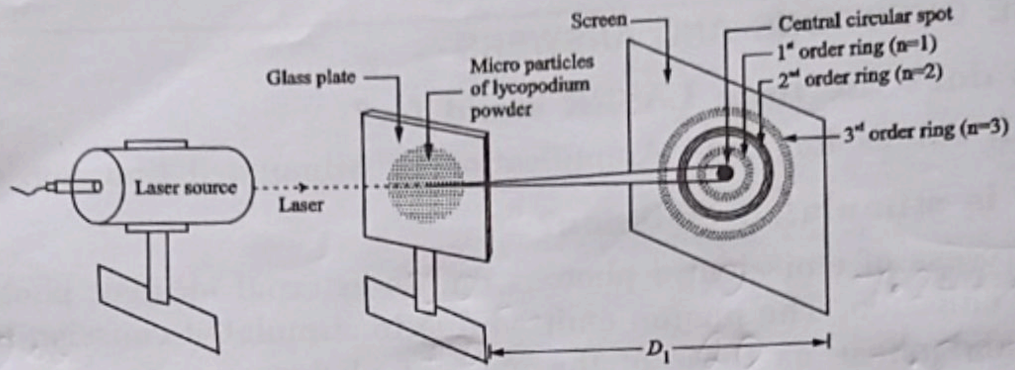


Fig. (a) Experimental set-up to produce diffraction circular rings for determining the particle size

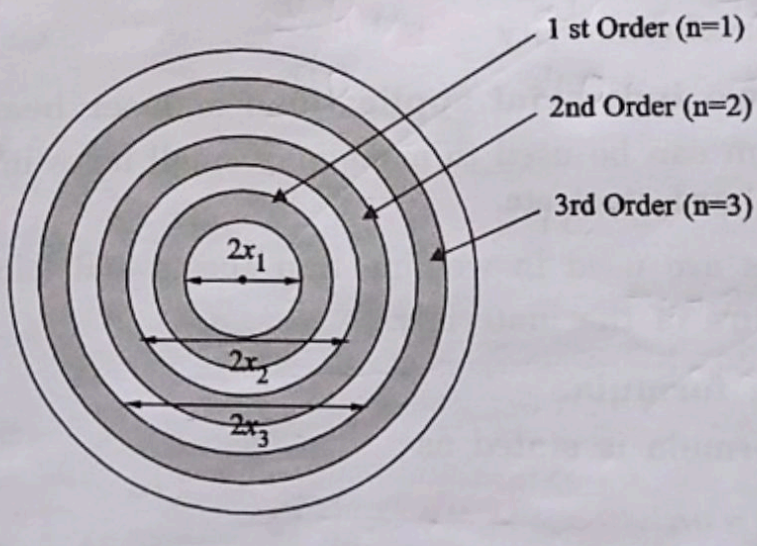


Fig. (b) Diffraction pattern - circular rings

2. DETERMINATION OF PARTICLE SIZE USING LASER

Expt. No:	02

Date: 24 09 2018

AIM

To determine the size of the given microparticles present in the lycopodium power using laser light.

APPARATUS REQUIRED

1. Laser source
2. Lycopodium powder with fine microparticles
3. Glass plate
4. Screen
5. Half metre scale

FORMULA

The size (diameter) of the given particles

$$d = \frac{n\,\lambda D_1}{x_n} \text{ metre}$$

EXPLANATION OF THE SYMBOLS

Symbol	Explanation	Unit
n	Order of diffraction	
λ	Wavelength of laser light used	metre
D_1	Distance between the glass plate and the screen	metre
x_n	Radii of different order dark rings	metre

(i) Determination of particle size

Wavelength of laser light used λ = 6900×10^{-10} m

Sl. No.	Distance between the screen and glass plate (D_1)	Order of circular rings (n)	Diameter of n^{th} dark ring	Radii of n^{th} dark ring (x_n)	Particle size $d = \frac{n \lambda D_1}{x_n}$
Unit	cm	–	cm	cm	m
1	10.5	1	20 ($2x_1$)	10 (x_1)	7,245×10^{-10}
2		2	40 ($2x_2$)	20 (x_2)	7,245×10^{-10}
3		3	($2x_3$)	(x_3)	
1	18.5	1	30 ($2x_1$)	15 (x_1)	8,530×10^{-10}
2		2	68 ($2x_2$)	34 (x_2)	7,508×10^{-10}
3		3	($2x_3$)	(x_3)	
1	23	1	40 ($2x_1$)	20 (x_1)	7,935×10^{-10}
2		2	80 ($2x_2$)	40 (x_2)	7,935×10^{-10}
3		3	($2x_3$)	(x_3)	

Mean (d) = 7.7298×10^{-10} m

= 7.7298 × 10^{-6} m

= 7.7298 µm

(ii) Calculation

I. Set

D_1 = ... cm and λ = ... m

1. For $n = 1$, $x_n = x_1$ cm = ... cm

$$d = \frac{1 \times \lambda \times D_1}{x_1} = \text{..........} \text{ m}$$

2. For $n = 2$, $x_n = x_2$ cm = 2×1×10^{-2} cm

$$d = \frac{2 \times \lambda \times D_1}{x_2} = 2 \times 6900 \times 10^{-10} \text{ m} \times 1 \times 10^{-2} = 6900 \times 10^{-12}$$

= 2×10^{-2}

3. For $n = 3$, $x_n = x_3$ cm = ... cm

$$d = \frac{3 \times \lambda \times D_1}{x_3} = \text{..........} \text{ m}$$

PROCEDURE

The experimental set-up to produce diffraction pattern (circular rings) for determining the particle size is shown in Fig. (a). A glass plate is cleaned well and fine lycopodium powder of particle size in the range of micrometer is sprinkled uniformly over the glass plate. The glass plate is placed between the laser source and the screen. The laser source is switched on and light is made to fall on the glass plate. Now, the laser beam gets diffracted by the particles present on the glass plate.

The distance between the glass plate and the screen is adjusted until a clear image of the circular rings pattern is obtained on the screen as shown in Fig.(b). The distance between the glass plate and the screen is measured as D_1. The diameters of the dark rings of different orders (n = 1, 2, 3, ...) are measured as $2x_1, 2x_2, 2x_3$ ... using a half metre scale. The radii of the dark rings are then calculated as x_1, x_2, x_3, ... The particle size is calculated using the formula,

$$d = \frac{n\lambda D_1}{x_n} m$$

The experiment is repeated for various values of D_1 and the mean value of the particle size is calculated.

$$\frac{1 \times 6900 \times 10^{-10} \times 10 \times 10^{-2}}{1 \times 10^{-2}} = 6900 \times 10^{-10}$$

$$= 6.9 \times 10^{-6} m$$

Result:

The average size of the given Particle = 7.729 μm

II. Set

$D_1 =$ 16.1 cm and $\lambda =$ 6900×10^{-10} m

1. For $n = 1$, $x_n = x_1$ cm = 1.5 cm

$$d = \frac{1 \times \lambda \times D_1}{x_1} = \frac{1 \times 6900 \times 10^{-10}}{1.5 \times 10^{-2}} \text{ m} \times 16.1 \times 10^{2} = 74037 \times 10^{-10}$$

2. For $n = 2$, $x_n = x_2$ cm = 3 cm

$$d = \frac{2 \times \lambda \times D_1}{x_2} = \frac{2 \times 6900^{-10}}{3 \times 10^{-2}} \text{ m} \times 16.1 \times 10^{-2} = 73968 \times 10^{-10}$$

3. For $n = 3$, $x_n = x_3$ cm = ... cm

$$d = \frac{3 \times \lambda \times D_1}{x_3} = \text{........................ m}$$

III. Set

$D_1 =$ 22 cm and $\lambda =$ 6900×10^{-10} m

1. For $n = 1$, $x_n = x_1$ cm = 2 cm

$$d = \frac{1 \times \lambda \times D_1}{x_1} = \frac{1 \times 6900 \times 10^{-10} \times 22 \times 10^{-2}}{42 \times 10^{-2}} \text{ m} = 75980 \times 10^{-10}$$

2. For $n = 2$, $x_n = x_2$ cm = ... cm

$$d = \frac{2 \times \lambda \times D_1}{x_2} = \frac{2 \times 6900 \times 10^{-10}}{11 \times 10^{-2}} \text{ m} \times 2 \times 10^{-2} = 75980 \times 10^{-10}$$

3. For $n = 3$, $x_n = x_3$ cm = ... cm

$$d = \frac{2 \times \lambda \times D_1}{x_3} = \text{........................ m}$$

RESULT

7·29675

The average size of the given particles = ... μm

VIVA-VOCE QUESTIONS AND ANSWERS

1. How are lasers classified?

Lasers are classified into five major categories.

(i)	Solid state lasers	–	Nd-YAG laser
(ii)	Gas lasers	–	CO_2 laser
(iii)	Liquid lasers	–	$SiOCl_2$ laser
(iv)	Semiconductor lasers	–	Gallium Arsenide laser
(v)	Chemical and dye lasers	–	Hydrogen fluoride chemical laser, Coumarine dye laser

2. What are the three important components of any laser device?

The essential components of a laser are

(i) An active medium,

(ii) A pumping source and

(iii) An optical resonator.

3. What is meant by an active medium in laser?

A medium in which population inversion is achieved is called an active medium.

4. What is meant by population inversion?

The creation of a situation in which the number of atoms (N_2) in the excited state (E_2) is greater than the number of atoms (N_1) in the ground state (E_1) is called population inversion.

5. What is a semiconductor laser?

A semiconductor diode laser is a specially fabricated $p-n$ junction device. When it is forward biased, it emits coherent light.

6. What is the order of the size of the micro-particles present in lycopodium powder?

The order of the size of the microparticles present in lycopodium powder is μ m.

7. What is the value of 1 μm?

$$1\ \mu m = 10^{-6}\ m$$

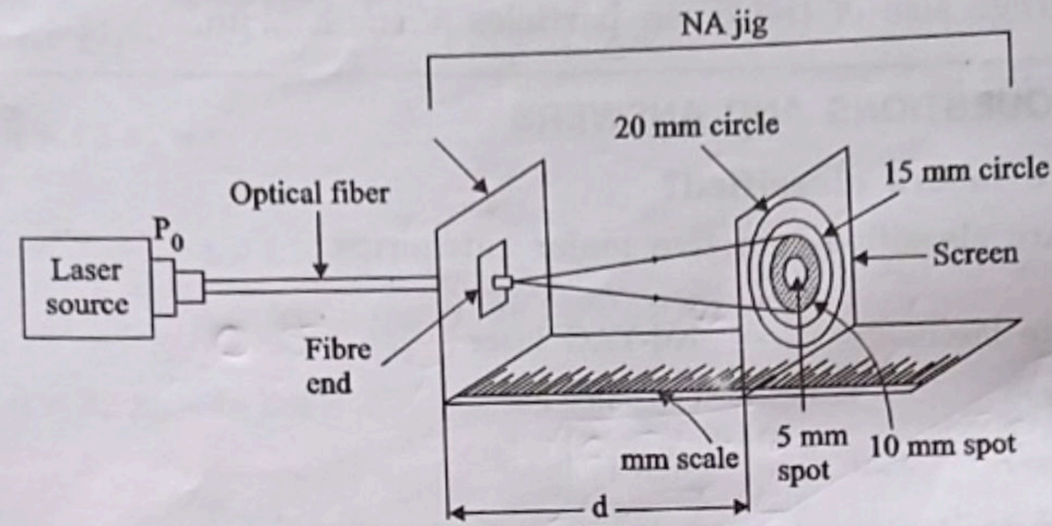


Fig. (a) Experimental set-up for the measurement of Numerical aperture and Acceptance angle

(i) Determination of Numerical Aperture and Acceptance angle

Sl. No.	Order (n)	Distance between the fibre end and the screen (d_n)	Radius of the circular image (r_n)	Numerical Aperture $NA = \frac{r_n}{\sqrt{r_n^2 + d_n^2}}$	Acceptance angle $\theta_a = \sin^{-1} NA$
Unit		mm	mm		degree
1.	1.	15 (d_1)	2.5	0.164	9.43°
2.	2.	22 (d_2)	5	0.221	12.76°
3.	3.	24 (d_3)	7.5	0.298	17.33°
4.	4.	29 (d_4)	10	0.326	19.02°
5.	5.	31 (d_5)	12.5 (r_5)	0.373	21.9°
6.	6.	39 (d_6)	15.0 (r_6)	0.358	20.97°

Mean = 0.285 ... Mean = 16.68 deg

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

Expt. No:	03

Date: 09 | 10 | 18

AIM

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

APPARATUS REQUIRED

1. Laser light source
2. Optical fibre cable
3. Numerical aperture jig
4. Screen with concentric circles
5. Half metre scale

FORMULAE

(i) Numerical aperture

$$NA = \sin \theta_a = \frac{r_n}{\sqrt{r_n^2 + d_n^2}}$$

(ii) Acceptance angle

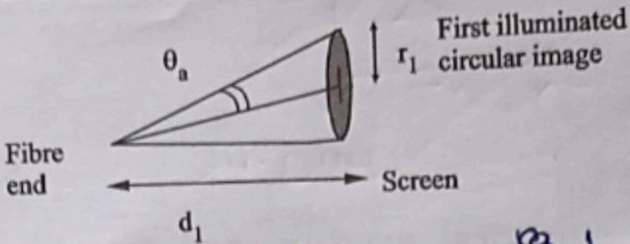
$$\theta_a = \sin^{-1} NA \text{ degree}$$

EXPLANATION OF THE SYMBOLS

Symbol	Explanation	Unit
r_n	Radius of the n^{th} illuminated circular image	metre
d_n	Distance between the fibre end and the screen with concentric circular images	metre

(ii) Calculation

1. For the first circular image ($n = 1$)

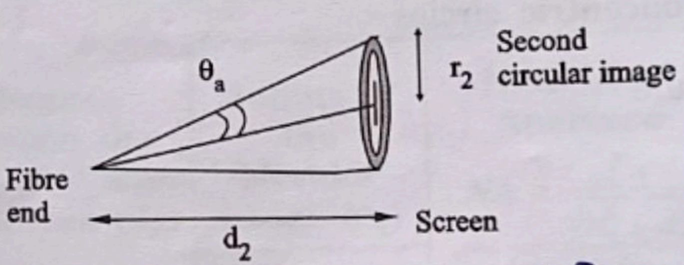


$r_1 =$ 0.5 cm, $d_1 =$ 1 cm

$NA = \sin\theta_a = \frac{r_1}{\sqrt{r_1^2 + d_1^2}} = \frac{0.5}{\sqrt{(0.5)^2 + 1^2}} =$ 0.4472

$\theta_a = \sin^{-1} NA =$ 26.5642 degree

2. For the second circular image ($x = 2$)



$r_2 =$ 0.75 mm, $d_2 =$ 1.8 cm

$NA = \sin\theta_a = \frac{r_2}{\sqrt{r_2^2 + d_2^2}} = \frac{0.75}{\sqrt{0.75^2 + 1.8^2}} =$ 0.3846

$\theta_a = \sin^{-1} NA =$ 22.6189 degree

3. For the third circular image ($x = 3$)

$r_3 =$ 1 cm, $d_3 =$ 2.2 cm

$NA = \sin\theta_a = \frac{r_3}{\sqrt{r_3^2 + d_3^2}} = \frac{1}{\sqrt{1^2 + 2.2^2}} =$ 0.41

$\theta_a = \sin^{-1} NA =$ 24.4438 degree

PROCEDURE

The experimental set-up for the measurement of numerical aperture and acceptance angle of a given optical fibre is shown in Fig. One end of the optical fibre is connected to a laser source and the other end is connected to a Numerical Aperture Jig (NA Jig). The NA Jig is provided with a screen consisting of concentric circles. The successive concentric circles are marked with increasing diameters starting from the first circle as 5 mm, 10 mm, 15 mm, etc. A horizontal scale is also provided to measure the distance between the fibre end and the screen.

The laser source is switched on. By adjusting the position of the screen, the first circle of diameter 5 mm is uniformly illuminated with red patch of light. The radius of the first circle is measured as r_1 using a half metre scale and the corresponding distance of the screen from the fibre end is measured as d_1 using the horizontal scale. Then, the Numerical Aperture (NA) and the Acceptance angle (θ_a) are calculated using the following formulae.

$$NA = \frac{r_1}{\sqrt{r_1^2 + d_1^2}} \qquad \left(\because NA = \frac{r_n}{\sqrt{r_n^2 + d_n^2}} \quad \text{Here } n = 1 \right)$$

$$\text{and } \theta_a = \sin^{-1} \text{NA degree}$$

The experiment is repeated by moving the screen so that the remaining concentric circles of diameters 10 mm, 15 mm, 20 mm, etc., are illuminated successively with uniform brightness. The radii r_2, r_3, r_4, etc., of the circles and the corresponding distances d_2, d_3, d_4 of the screen from the fibre end are measured respectively.

$$\text{Then } NA = \frac{r_2}{\sqrt{r_2^2 + d_2^2}} \text{ (Here } n = 2)$$

$$\text{and } \theta_a = \sin^{-1} \text{NA degree}$$

Similarly, NA and θ_a are calculated for $n = 3, 4, 5$, etc., and the mean value of NA and θ_a are determined.

Resut:

The numerical aperture of the given optical fibre = 0.285

The Acceptance angle of the given optical fibre = 16.90

4. For the fourth circular image $(x = 3)$

$r_4 =$ 1.25 cm, $d_4 =$ 2.8 cm

$$NA = \sin\theta_a = \frac{r_4}{\sqrt{r_4^2 + d_4^2}} = \frac{1.25}{\sqrt{1.25^2 + 2.8^2}} = 0.4097$$

$\theta_a = \sin^{-1}(NA) =$ 24.0184 degree

5. For the fifth circular image $(x = 5)$

$r_5 =$ 1.50 cm, $d_5 =$ 3.3 cm

$$NA = \sin\theta_a = \frac{r_5}{\sqrt{r_5^2 + d_5^2}} = \frac{1.5}{\sqrt{1.5^2 + 3.3^2}} = 0.4138$$

$\theta_a = \sin^{-1}(NA) =$ 24.4438 degree

6. For the sixth circular image $(x = 6)$

$r_6 =$ .... mm, $d_6 =$ .... mm

$$NA = \sin\theta_a = \frac{r_6}{\sqrt{r_6^2 + d_6^2}} = \frac{\quad}{\quad} = \ldots\ldots$$

$\theta_a = \sin NA =$ .... degree

RESULT

(i) The mean value of Numerical aperture of the given optical fibre = 0.4134

(ii) The mean value of Acceptance angle of the given optical fibre = ... degree 24.4262

VIVA-VOCE QUESTIONS AND ANSWERS

1. Define acceptance angle.

The maximum angle at which the light ray enters the core for which total internal reflection just occurs at the core-cladding interface is called acceptance angle.

2. Define numerical aperture.

The sine of the acceptance angle (θ_0) of the fibre is called Numerical Aperture (NA).

$$NA = \sin \theta_0$$

3. What is the principle of optical fibre?

The principle of light transmission through an optical fibre is total internal reflection.

4. What are the types of optical fibres based on number of modes?

They are: (i) Single mode fibre and (ii) Multimode fibre

5. What are the types of optical fibres based on the refractive index profile?

They are: (i) Step index fibre and (ii) Graded index fibre

6. Mention the components involved in fibre optic communication system.

(i) Transmitter

(ii) Optical fibre and

(iii) Receiver

7. State any three advantages of fibre optic communication system.

(i) Large number of channels can be transmitted.

(ii) Cross-talk is negligible

(iii) Optical fibres have a longer life span.

(iv) Optical fibre communication is economical.

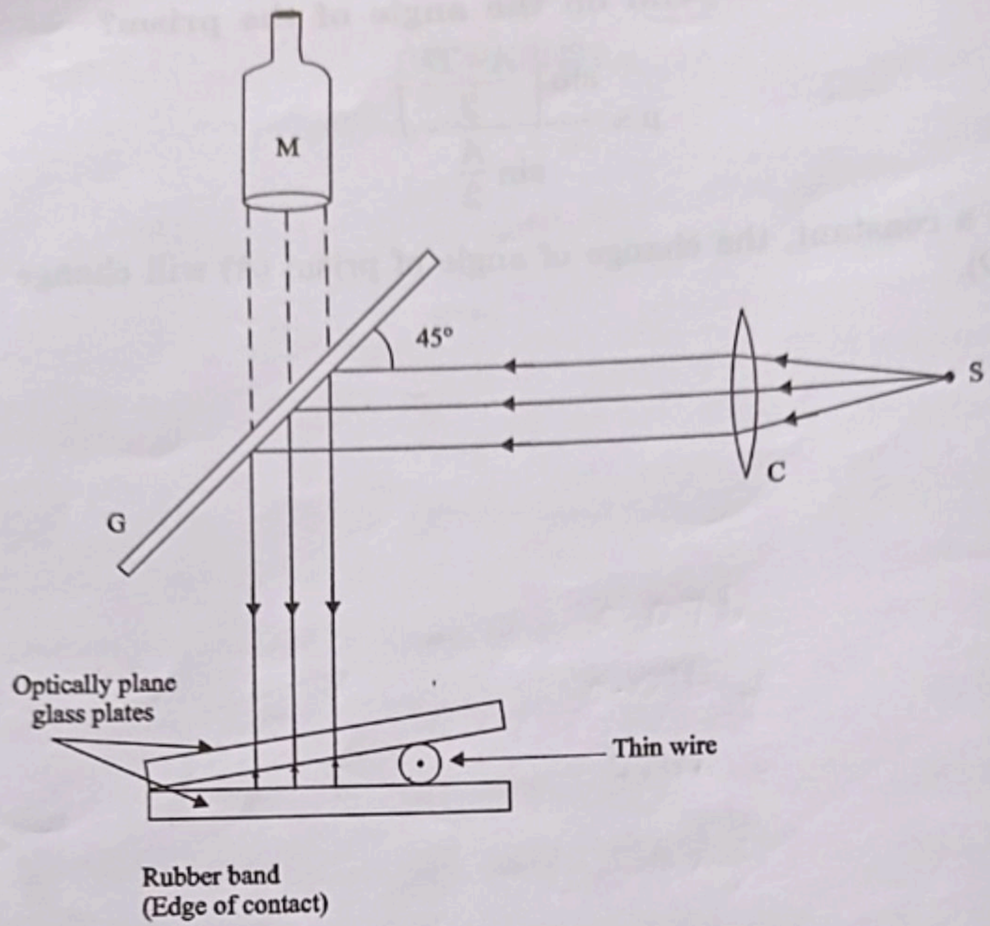


Fig. (a) Air-wedge-Experimental set-up

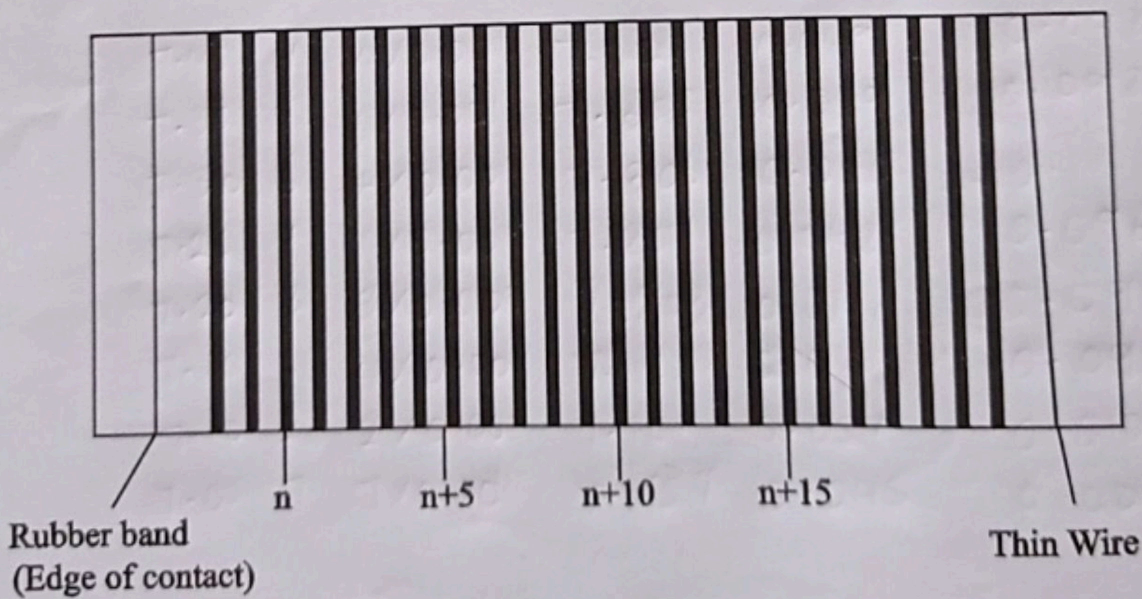


Fig. (b) Interference pattern – Alternate bright and dark straight bands

5. DETERMINATION OF THICKNESS OF A THIN WIRE – AIR WEDGE METHOD

Expt. No:	04

Date: 02 | 02 | 2019

AIM

To determine the thickness of a given thin wire by forming interference fringes using air-wedge method.

APPARATUS REQUIRED

1. Travelling microscope
2. Sodium vapour lamp
3. Two optically plane rectangular glass plates
4. Condensing lens
5. Reading lens
6. Given thin wire

FORMULA

The thickness of the given thin wire,

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

EXPLANATION OF THE SYMBOLS

Symbol	Explanation	Unit
λ	Wavelength of sodium light	metre
l	Distance between the edge of contact (rubber band) and the wire	metre
β	Bandwidth	metre

(i) Least count of the Travelling Microscope

Least count = 1 Main Scale Division (MSD) − 1 Vernier Scale Division (VSD)

$$20 \text{ MSD} = 1 \text{ cm}$$

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

$$50 \text{ VSD} = 49 \text{ MSD}$$

$$= 49 \times 0.05 \text{ cm}$$

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

$$\mathbf{LC = (0.05 - 0.049) \text{ cm} = 0.001 \text{ cm}}$$

(ii) Determination of bandwidth (β)

LC = 0.001 cm

Sl. No.	Order of the dark band	Microscope readings				Width of 15 dark bands	Bandwidth (β)
		MSR	VSC	VSR = VSC × LC	TR = MSR + VSR		
Unit		cm	div.	cm	cm	cm	cm
1.	n	7.45	4	4×0.001	7.404	0.049	0.098
2.	$n+5$	7.35	5	5×0.001	7.355	0.049	0.098
3.	$n+10$	7.30	6	6×0.001	7.306	0.055	0.11
4.	$n+15$	7.25	1	1×0.001	7.251	0.048	0.096
5.	$n+20$	7.20	3	3×0.001	7.203	0.048	0.096
6.	$n+25$	7.15	4	4×0.001	7.154	0.049	0.098
7.	$n+30$	7.10	2	2×0.001	7.102	0.052	0.0104
8.	$n+35$	7.05	7	7×0.001	7.057	0.045	0.089
9.	$n+40$						
10.	$n+45$						

Mean (β) = ...0.017......... cm

= .....0.017...... $\times 10^{-2}$ m

PROCEDURE

Two optically plane glass plates are held firmly together at one end with the help of a rubber band. The given wire is placed at the other end. Now, an air-film of varying thickness is formed between the two glass plates. This arrangement is called air-wedge. The experimental set-up is shown in Fig.(a).

Light from a sodium lamp (S) is rendered parallel by a convex lens (C). The parallel rays of light fall on a glass plate (G) inclined at 45° to the horizontal bed of a travelling microscope. The light reflected from the glass plate falls vertically on the air-wedge. Interference takes place between the rays of light reflected from the top and lower surfaces of the air film between the optically plane glass plates. Alternate bright and dark straight bands (Fig. b) are formed depending upon the path difference between the light rays. The microscope is focussed on the interference bands. The fine adjustment screw at the side of the horizontal platform of the microscope is worked such that the vertical cross-wire coincides with the fixed edge of any darkband say, n^{th} dark band. The main scale reading and the corresponding Vernier scale coincidence are noted. The total microscope reading is then calculated.

$$TR = (MSR + VSR) \text{ cm}$$

$$\text{where } VSR = (VSC \times LC)$$

The observations are repeated for $n + 5, n + 10, n + 15, n + 20$ .... dark bands respectively by adjusting fine adjustment screw. From this the width of 15 dark bands is determined and hence the bandwidth β is calculated. The distance l between the rubber band and the wire is measured using the travelling microscope. The wavelength (λ) of sodium light is taken from the data given at the end of the book.

The thickness of the given thin wire is calculated using the formula.

Result:
The thickness of the given thin wire = 7.70391 x 10

(iii) To measure the distance (l) between the rubber band and the given wire

LC = 0.001 cm

Position	Microscope readings				$l = H_2 - H_1$
	MSR	VSC	VSR = VSC × LC	TR = (MSR + VSR)	
Unit	cm	div.	cm	cm	cm
Rubber band				(H_1)	3.42
Given wire				(H_2)	

(iv) Calculation

The mean bandwidth (β) = 0.076 cm

= 0.076 $\times 10^{-2}$ m

The distance between the rubber band and the given wire } l = 3.42 cm

= 3.42 $\times 10^{-2}$ m

The wavelength of sodium light $\lambda = 5893 \times 10^{-10}$ m

The thickness of the given wire,

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

$$= \frac{5893 \times 10^{-10} \times 3.4 \times 10^{-2}}{2 \times 0.076 \times 10^{-2}}$$

$$= 770391 \times 10^{-10} \text{ m}$$

$$t = 7.70391 \times 10^{-5} \text{ m}$$

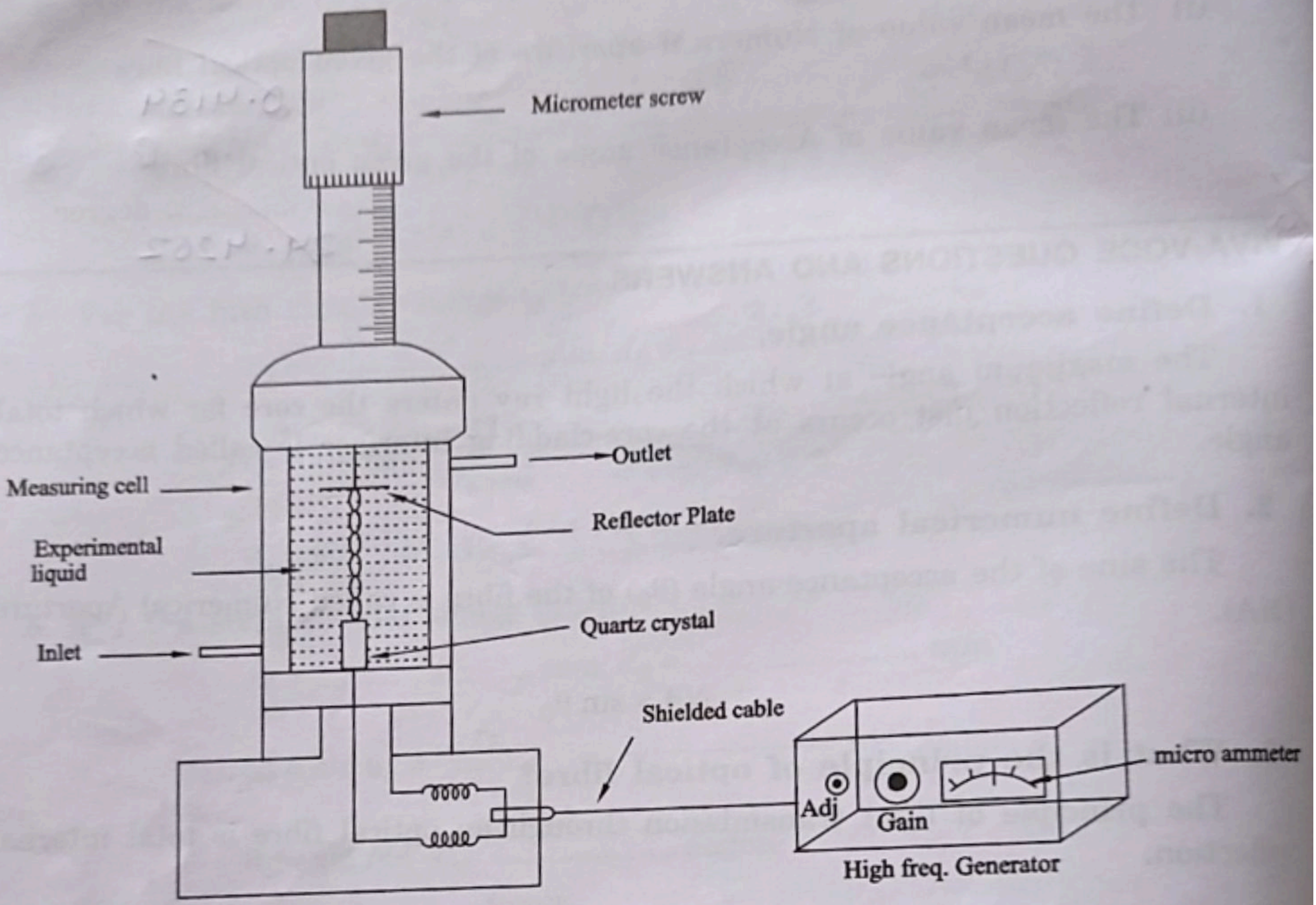


Fig. (a) Ultrasonic Interferometer

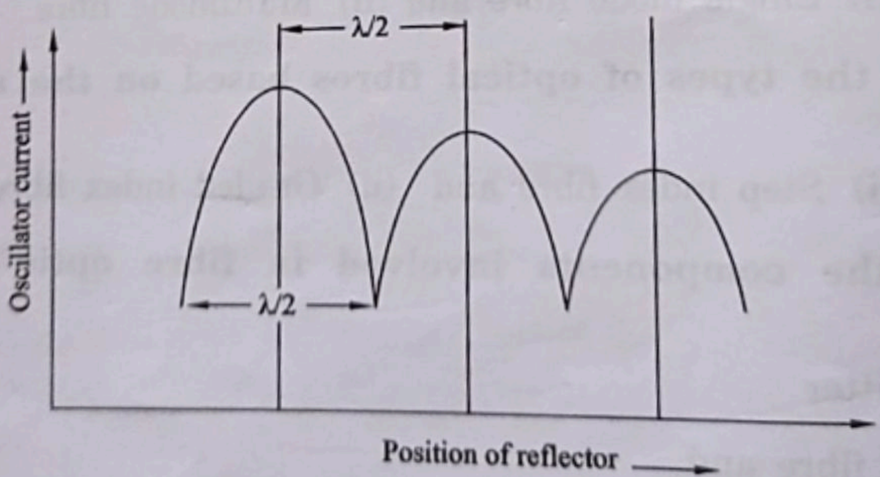


Fig. (b) Distance moved by the reflector versus oscillator current

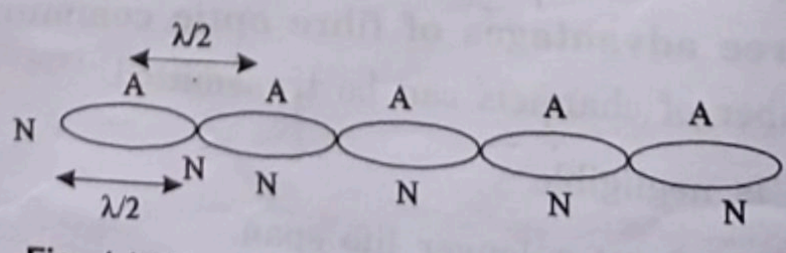


Fig. (c) Wave pattern formed in the liquid

4. DETERMINATION OF VELOCITY OF SOUND AND COMPRESSIBILITY OF LIQUID – ULTRASONIC INTERFEROMETER

Expt. No: 2

Date: 22 09 16

AIM

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

APPARATUS REQUIRED

1. Ultrasonic interferometer
2. Frequency generator
3. Given liquid

FORMULAE

(i) The velocity of ultrasonic waves in a liquid

$$v = f\lambda \ \mathrm{ms^{-1}}$$

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

(ii) The compressibility of the given liquid

$$K = \frac{1}{v^2 \rho} \ \mathrm{m^2 N^{-1}}$$

EXPLANATION OF THE SYMBOLS

Symbol	Explanation	Unit
f	Frequency of the ultrasonic waves	hertz
λ	Wavelength of ultrasonic waves	metre
d	Distance moved by the micrometer screw	metre
n	Number of successive maxima	
ρ	Density of the liquid	$\mathrm{kg\,m^{-3}}$

(i) Measurement of the distance moved by the reflector (micrometer screw)

Least count = 0.01 mm

Sl. No.	Number of Maxima	Micrometer readings: Pitch scale Reading (PSR)	Head scale coincidence (HSC)	Head scale Reading = (HSR = HSC × LC)	Total Reading TR = PSR + HSR	Distance moved (*d*) for (*n* = 15) maxima
Unit		mm	div.	mm	mm	mm
1.	*n*	12	1	0.01	12.01	0.33
2.	*n* + 5 1	11.5	18	0.18	11.68	0.33
3.	*n* + 10 2	4	35	0.35	11.35	0.35
4.	*n* + 15 3	11	0	0	11	0.25
5.	*n* + 20 4	10.5	25	0.25	10.75	0.69
6.	*n* + 25 5			–	–	—
7.	*n* + 30 6	10	6	0.06	10.06	0.26
8.	*n* + 35 7	9.5	30	0.30	9.80	0.31
9.	*n* + 40 8		49	0.49	9.45	0.33

Mean (*d*) = 0.31 mm

n+9	9	16	0.16	9.16	0.34
n+10	8.5	32	0.32	8.82	0.27
n+11	8.5	5	0.05	8.55	0.32
n+12	8	23	0.023	8.23	0.33
n+13	7.5	40	0.40	7.90	0.32
n+14	7.5	8	0.08	7.58	0.34
n+15	7	24	0.24	7.24	

0.31 mm

DESCRIPTION

Ultrasonic interferometer is a device which can be used to determine the velocity of ultrasonic waves in a liquid. It consists of following two parts as shown in Fig.(a).

1. High frequency generator
2. Measuring cell

The high frequency generator can generate alternating voltage of high frequency of the order 2 MHz. This high frequency voltage can excite the quartz plate placed at the bottom of the measuring cell. The excited quartz crystal will generate ultrasonic waves in the liquid taken in the measuring cell due to inverse piezo-electric effect. A reflector plate is placed near top surface of the liquid. When ultrasonic waves pass through the liquid, the waves are reflected back by the plate to form standing waves within the liquid. Now, the liquid acts as an ***acoustic grating.*** A micrometer screw is fitted at the top of the cell. The high frequency generator is provided with two knobs, one marked as 'Adj' and the other marked as 'Gain'.

PROCEDURE

The measuring cell is first cleaned well and filled with the given liquid. The measuring cell is connected to the output terminal of the high frequency generator.

The high frequency generator is switched on. Before starting the experiment, the 'Adj' knob is adjusted so that the needle in the micro-ammeter shows zero reading and the 'Gain' knob is adjusted for maximum deflection in the micro-ammeter. The least count of the micrometer screw is determined before starting the experiment.

The distance between the reflector and the crystal is changed by rotating the micrometer screw so that the anode current in the generator increases from zero to maximum, decreases from maximum to zero and then increases to maximum. For the successive maxima or minima in the anode current, the distance moved by the micrometer screw is equal to half the wavelength ($\lambda/2$) of the ultrasonic waves in the liquid as shown in Fig. (b). This is also equal to the distance between successive nodes (N) or antinodes (A).

When the pointer shows the maximum anode current, Pitch Scale Reading (PSR) and Head Scale Coincidence (HSC) are noted in the micrometer. The Total Reading of the micrometer is given by $\mathrm{TR} = (\mathrm{PSR} + \mathrm{HSR})$ mm where Head Scale Reading $(\mathrm{HSR}) = \mathrm{HSC} \times \mathrm{LC}$. This reading corresponds to n^{th} maximum in the anode current. The micrometer screw is then rotated and the micrometer readings are recorded for every five successive maxima in the anode current and tabulated.

(ii) Calculation for determining velocity of ultrasonic waves in the liquid and compressibility of liquid

The mean distance moved by the micrometer screw,

$$d = \text{0.31} \times 10^{-3}\ \text{m}$$

$$n = 15$$

$$\lambda = \frac{2d}{n} = \frac{0.62}{15} = \text{0.62} \times 10^{-3}\ \text{m}$$

$$f = \text{2}\ \text{MHz} = \text{2} \times 10^{6}\ \text{Hz}$$

$$v = f\lambda\ \text{ms}^{-1}$$

$$v = \text{2} \times 10^{6} \times \text{0.62} \times 10^{-3}\ \text{ms}^{-1}$$

$$= \text{1.24}\ \text{ms}^{-1}$$

$$K = \frac{1}{v^2 \rho}\ \text{m}^2\,\text{N}^{-1}$$

$$\rho = \text{790}\ \text{kg/m}^3$$

$$\therefore K = \underline{\qquad\qquad} = 8.232 \times 10^{-10}\ \text{m}^2\,\text{N}^{-1}$$

The distance (d) moved by the micrometer screw for n (= 15) successive maxima are calculated from the observations.

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

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

Using the value of λ, the velocity of ultrasonic waves in the liquid is calculated using the formula,

$$v = f\lambda\ \text{ms}^{-1}$$

where f is the frequency of the ultrasonic waves. After determining the velocity of ultrasonic waves in the liquid, the compressibility of the liquid is calculated using the formula

$$K = \frac{1}{v^2 \rho}\ \text{m}^2\,\text{N}^{-1}$$

where ρ is the density of the liquid. The experiment can be repeated for different liquids. The density of the liquid can be taken from the data given at the end of the book.

RESULT

(i) The velocity of ultrasonic waves in the given liquid = $1.24 \times 10^{+3}$ m s^{-1}

(ii) The compressibility of the given liquid = 8.23×10^{-10} m^2 N^{-1}

VIVA-VOCE QUESTIONS AND ANSWERS

1. What are the different types of sound waves?

Different types of sound waves:

(i) Infrasonic waves

(ii) Audible sound waves

(iii) Ultrasonic waves

2. What are ultrasonic waves?

Sound waves with frequencies above 20 kHz are called ultrasonic waves.

3. Name the methods by which ultrasonic waves are produced.

They are (i) magnetostriction oscillator and (ii) piezoelectric oscillator

4. What is piezoelectric effect?

When one pair of opposite faces of a quartz crystal is compressed, then equal and opposite electrical charges are developed on the other pair of opposite faces of the crystal. This is called direct piezoelectric effect.

5. What is inverse piezoelectric effect?

If an electric field is applied across one pair of opposite faces of a quartz crystal, it gets deformed along the direction of the other opposite pair of faces of the crystal. This is known as inverse piezoelectric effect.

6. What is the principle of working of piezoelectric oscillator?

Inverse piezoelectric effect.

7. What is acoustic grating?

When ultrasonic waves travel in a liquid medium from one end and get reflected from the other end, stationary waves are formed in the medium with nodes and antinodes. The nodes will behave like opaque portions and the antinodes will behave like transparent portions. Hence, this arrangement is called acoustic grating.

8. Mention the unit of compressibility.

Unit: m^2/N

9. Mention the important properties of ultrasonic waves.

(i) Ultrasonic waves have a frequency greater than 20 kHz.

(ii) They get reflected, refracted and absorbed like ordinary sound waves in the material media.

(iii) They can travel over long distance without appreciable loss of energy.

(iv) They can generate heat when absorbed by a medium.

(v) Acoustic grating can be formed in a liquid using ultrasonic waves.

(vi) They can produce cavitation in a liquid.

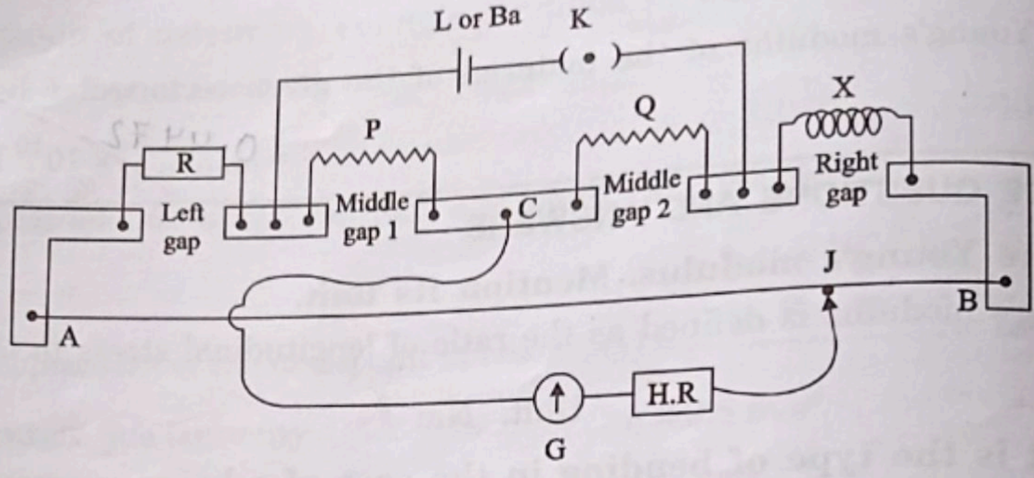


Fig. Carey-Foster's Bridge

(i) To find the resistance of the bridge wire per cm (ρ)

l_1 = Balancing length when the resistance R and the copper strip are connected in the left gap and right gap respectively.

l_2 = Balancing length when the resistance R and the copper strip are interchanged.

Sl. No.	Resistance in R	Balancing lengths		$\rho = \frac{R}{(l_2 - l_1)}$
		Before interchanging (l_1)	After interchanging (l_2)	
Unit	ohm	cm	cm	ohm/cm
1.	0.1	42	40.2	0.055
2.	0.2	37	36.5	0.133
3.	0.3	25	25	0
4.	0.4	26	24.5	0.266
5.	0.5	11.5	14	0.2
6.	0.6	16.2	15	0.5

Mean (ρ) = 0.19233 ohm/cm

6. DETERMINATION OF SPECIFIC RESISTANCE OF A GIVEN COIL OF WIRE – CAREY FOSTER BRIDGE

Expt. No:	

Date: | | | |

AIM

To determine the specific resistance of the given coil of wire by knowing its resistance using Carey-Foster's bridge.

APPARATUS REQUIRED

1. A Carey-Foster's bridge
2. A coil of given wire (X)
3. A Leclanche cell or a battery (Ba)
4. Plug key
5. Two equal resistances P and Q
6. Galvanometer
7. Resistance box (R)
8. High resistance
9. Jockey
10. A copper strip (zero resistance)
11. Connecting wires

FORMULAE

(i) The resistance of the given coil of wire,

$$X = R - (l_2 - l_1)\,\rho \text{ ohm}$$

(ii) The specific resistance of the given coil of wire

$$S = \frac{\pi r^2 X}{l} \text{ ohm-metre}$$

(ii) To determine the unknown resistance X

Sl. No.	Resistance in the box (R)	Balancing length: Before interchanging (l_1)	Balancing length: After interchanging (l_2) cm	$X = R - (l_2 - l_1)\rho$
Unit	ohm	cm	cm	ohm
1.	6.3	45	33	4.02
2.	6.4	44	38	2.26
3.	6.5	54	50	5.74
4.	6.6	54.2	48	5.4
5.	6.7	59.5	52.5	8.03

Mean (X) = ...5.09...... ohm

(iii) Measurement of diameter (d) of the given coil of wire (screw gauge readings)

LC = 0.01 mm

ZE = Nil   ZE = + ... division   ZE = – (100 – ....) division

ZE = – .... division

ZC = Nil   ZC = – .... × LC   ZC = + ... × LC

= – .... × 0.01 mm   = + ... × 0.01 mm

= – .... mm   = + ... mm

Sl. No.	Pitch Scale Reading (PSR)	Head Scale Coincidence (HSC)	Head Scale Reading (HSR) = HSC × LC	Observed Reading (OR) = PSR + HSR	Corrected Reading (CR) = OR ± ZC
Unit	mm	div.	mm	mm	mm
1.	0	39	0.39	0.39	0.39
2.	0	34	0.34	0.34	0.34
3.	0	33	0.33	0.33	0.33
4.					
5.					
6.					

Mean (d) = ..0.353..... mm

= ...0.353.. $\times 10^{-3}$ m

(iv) Calculation to determine ρ

1. $\rho = \frac{R}{l_2 - l_1}$ = ——— = ... ohm/cm

EXPLANATION OF THE SYMBOLS

Symbol	Explanation	Unit
R	Known resistance in the box	ohm
l_1	Balancing length before interchanging	metre
l_2	Balancing length after interchanging	metre
ρ	Resistance of the bridge wire per unit length	ohm/m
X	Unknown resistance	ohm
l	Length of the given coil of wire	metre
r	Radius of the given coil of wire	metre

DESCRIPTION

A Carey-Foster bridge consists of a one metre wire (AB) of uniform resistance on a wooden board. A metre scale is fixed parallel to the wire on the wooden board to measure the balancing lengths. The bridge has four gaps marked as left gap, right gap and two middle gaps between the copper strips fixed on the wooden board.

PROCEDURE

(i) To determine the resistance per metre of the bridge wire (ρ)

The connections are made as shown in Fig.(a). Two standard equal resistances P and Q (5 or 10 ohms) are connected in the middle gaps 1 and 2 respectively. The point C between P and Q is connected to the jockey (J) through a galvanometer (G) and a high resistance (HR). For determining the resistance of the bridge wire per cm (ρ), the resistance R is connected in the left gap and the copper strip ($X=0$) is connected in the right gap. The terminal between R and P is connected to the terminal between Q and X through the Leclanche cell (L) or battery (Ba) and the plug key (K).

With the value of 0.1 Ω in the resistance box R (left gap) and the copper strip ($X=0$) in the right gap, the circuit is closed by closing the key K. The jockey is pressed on the wire near A and then near B including the high resistance in the galvanometer circuit. If the deflections in the galvanometer are in the opposite directions, it is ensured that the connections are correct.

Now, the jockey is moved on the wire from the point A and the galvanometer shows zero deflection for a particular position. That point is called balancing point J. The length $AJ=l_1$ cm is called balancing length. The high resistance is cut-off and the accurate balancing length $AJ=l_1$ cm is measured. The resistance R and the copper strip are interchanged and the observation is repeated. The accurate balancing length $AJ = l_2$ cm is now measured. The experiment is repeated for various values of $R = 0.2, 0.3, 0.4, 0.5, 0.6$ ohms and the value of resistance per cm of the bridge wire (ρ) is calculated using the formula as shown in tabular column 1. The mean value of ρ is determined.

(ii) To determine the resistance (X) of the given coil of wire

The copper strip is removed and the given coil of wire (X) is connected in the right gap. The box (R) is connected in the left gap. The circuit is closed by closing the key K. A suitable resistance of integral value, say 2 or 3 or 4 ohms is introduced in R. The balance point is found out using the jockey including the high resistance in the galvanometer circuit. The approximate balancing length $AJ = l_1$ cm is noted. The high resistance is cut-off and the accurate balancing length l_1 cm is measured. The observation is repeated after interchanging R and X and the accurate balancing length l_2 cm is measured. The experiment is repeated for various values of R and the value of unknown resistance X is calculated for each value of R as shown in tabular column. The mean value of X is determined. The length (l) of the given coil of wire is measured using a metre scale and the radius (r) of the coil of wire is found using a screw gauge. The specific resistance of the material of the given coil of wire is calculated using the formula.

RESULT

(i) The resistance of the given coil of wire = ..5.09.. ohm

(ii) The specific resistance of the material of the given coil of wire

= ..2.085.. $\times 10^{-6}$ ohm-metre

VIVA-VOCE QUESTIONS AND ANSWERS

1. Define specific resistance. Mention its unit.

The specific resistance of a material is the resistance of one metre length of wire whose area of cross-section is $1\,m^2$. Its unit is ohm – metre.

2. Define resistance.

At a constant temperature, the ratio of the potential difference V) applied across the ends of the conductor to the electric current (I) flowing through the conductor is defined as the resistance of the conductor.

$$R = \frac{V}{I}$$

3. What is the effect of temperature on the resistance of a conductor?

The resistance of a conductor increases with increase of temperature.

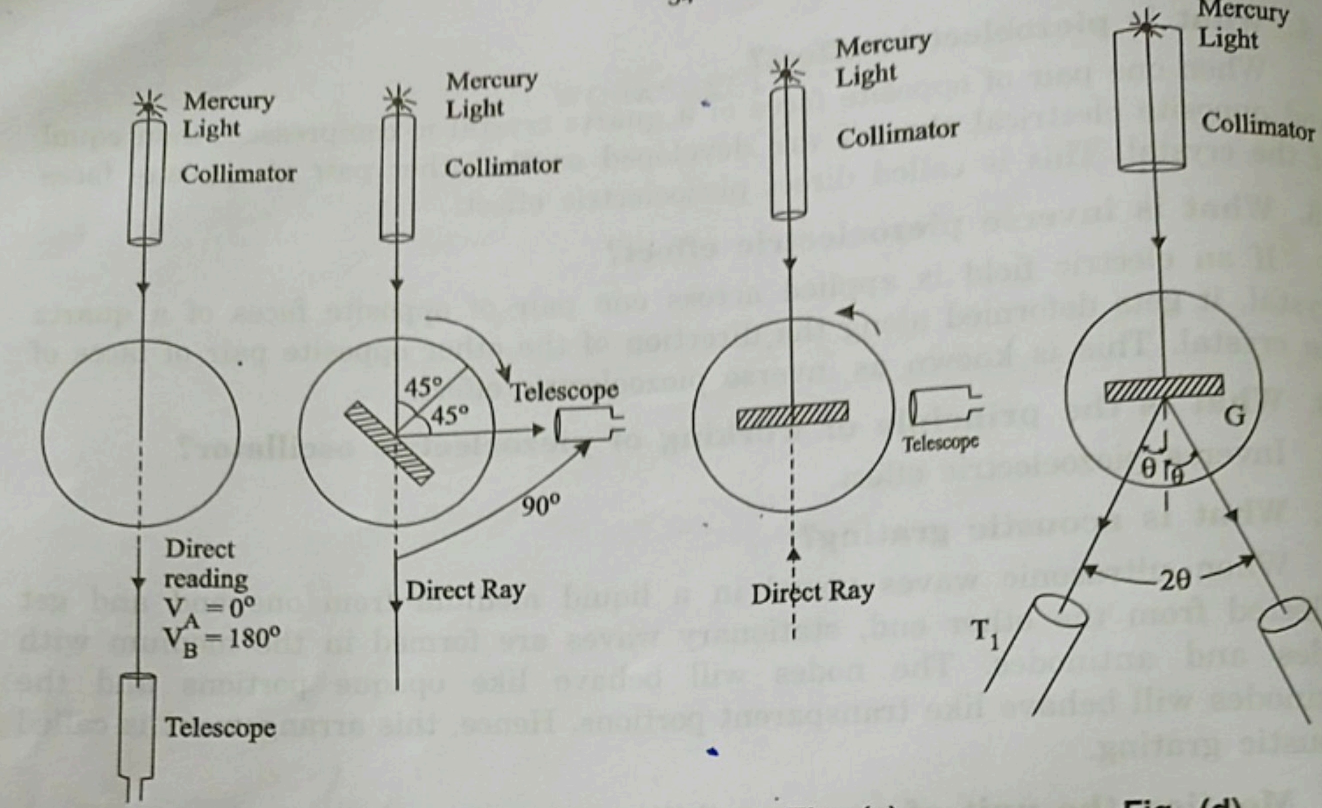


Fig. (a) Fig. (b) Fig. (c) Fig. (d)

(i) Determination of Least count of spectrometer

$$20 \text{ MSD} = 10°$$

$$2 \text{ MSD} = 1°$$

$$1 \text{ MSD} = \frac{1°}{2} = 30' \quad (\because 1° = 60')$$

$$30 \text{ VSD} = 29 \text{ MSD} = 29 \times 30'$$

$$1 \text{ VSD} = \frac{29 \times 30'}{30} = 29'$$

$$\text{Least count} = 1 \text{ MSD} - 1 \text{ VSD} = 30' - 29'$$

$$\boxed{\text{LC} = 1'}$$

(ii) Determination of Number of lines/m (*N*) in the grating

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

λ for green colour $= 5461 \times 10^{-10}$ m

$m = 1$

$$N = \frac{15{,}000}{5461 \times 10^{-10} \times 1} = 5.9 \times 10^{5} \text{ lines/m}$$

(for green colour θ to be taken from the tabular column)

5. DETERMINATION OF WAVELENGTHS OF MERCURY SPECTRUM – SPECTROMETER GRATING

Expt. No: 07

Date: 20 | 03 | 2019

AIM

To determine the wavelengths of the prominent spectral lines of mercury spectrum using a plane transmission grating.

APPARATUS REQUIRED

1. Spectrometer
2. Plane transmission grating
3. Mercury vapour lamp
4. Spirit level
5. Reading lens

FORMULA

The wavelength of the prominent lines of mercury spectrum is given by

$$\lambda = \frac{\sin\theta}{Nm} \text{ m}$$

EXPLANATION OF THE SYMBOLS

Symbol	Explanation	Unit
θ	Angle of diffraction	degree
m	Order of spectrum	1
N	Number of lines per metre in the grating	lines/m

(iii) Determination of wavelengths of mercury spectrum

LC = 1′, N = ...600000.......... lines/m, m = 1, VSR = $\dfrac{\text{VSC} \times \text{LC}}{60}$ degree, Total Reading (TR) = (MSR + VSR) degree

Spectral lines	Telescope readings for diffracted images												Difference between A_1 and A_2 (2 θ)	Difference between B_1 and B_2 (2 θ)	Mean (2 θ)	θ	$\lambda = \frac{\sin\theta}{Nm}$
	Left side						Right side										
	Vernier A (V_A) Readings			Vernier B (V_B) Readings			Vernier A (V_A) Readings			Vernier B (V_B) Readings							
	MSR	VSC	TR (A_1)	MSR	VSC	TR (B_1)	MSR	VSC	TR (A_2)	MSR	VSC	TR (B_2)					
	degree	div.	degree	degree	div.	degree	degree	div.	degree	degree	div.	degree	degree	degree	degree	degree	Å
Red	195°	3'	195°3'	375°	23'	375°23'	265°	18'	265°18'	95°30'	17'	95°47'	70°13'	280°35'	87°42'	87°42'	6653×10^{-6}
Orange ~~Yellow-2~~	196°	2'	196°2'	376°	25'	376°25'	260°30'	15'	260°45'	441°30'	13'	441°43'	70°13'	279°35'	86°42'	86°42'	5.5×10^{-6}
Yellow-1	196°30'	5'	196°35'	376°30'	28'	376°58'	261°	6'	261°6'	440°30'	23'	440°53'	70°14	278°37	85°42'	85°42	5.7×10^{-6}
Green	197°30'	3'	197°33'	377°30'	24'	377°54'	256°30'	10'	257°40'	488°	12'	438°12'	73°14'	277°31	84°42'	84°41	5461 5.2×10^{-6}
Bluish green																	
Blue																	
Violet	201°	5'	201°5'	381°	19'	381°19'	248°30'	22'	248°22'	428°30'	14'	428°43'	72°13	278°42	85°43	86°41	4.1×10^{-6}

PROCEDURE

(i) Adjustment of the grating for Normal incidence

Before starting the experiment, the initial adjustments of the spectrometer are made for obtaining clear image of the slit illuminated by mercury light. Now, the telescope is in line with the collimator. The Vernier table is then rotated so that one Vernier marked as V_A reads 0° and the other Vernier marked as V_B reads 180°. These are the readings for the direct image (Fig. a). The grating is vertically mounted in the holder placed on the prism table approximately perpendicular to the light rays coming from the collimator. The telescope is rotated through an angle 90° (either left side or right side) and fixed in this position as shown in Fig. (b).

On seeing through the telescope, the prism table is rotated (clockwise direction) until the fixed edge of the image of the slit coincides with the vertical cross-wire. This is possible only when the light coming from the collimator is incident at an angle 45° to the grating (Fig b). Now, the Vernier table along with the prism table is rotated in the opposite direction through 45° (Anticlockwise direction). Hence the grating is exactly normal to the light rays coming from the collimator (Fig. c). This is the experimental procedure of adjusting the grating for normal incidence.

(ii) Wavelengths of the prominent lines of mercury spectrum

The telescope is then released and various spectral lines (Red, yellow-2, yellow-1, green, bluish green, blue, violet) of the mercury spectrum of first order are seen through the telescope on either side of the direct image as shown in Fig.(d). The telescope is moved to the left side and the telescope is adjusted using the fine adjustment screw so that the fixed edge of the red colour coincides with the vertical cross-wire. The telescope readings are taken by observing the main scale reading and the Vernier scale coincidence corresponding to the two Verniers V_A and V_B. Similarly, the telescope readings are taken for all the spectral lines from left side to right side using the fine adjustment screw. The difference between the two Vernier readings A_1 and A_2 and B_1 and B_2 for a particular line on either side of the direct image gives 2θ for that particular colour and the mean value 2θ is determined. Using the value of θ and the value of λ for the green colour for the first order $m = 1$, the number of lines per metre (N) in the grating is calculated using the following formula,

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

where λ for green colour $= 5461 \times 10^{-10}$ m

Using the angles of diffraction (θ) for other spectral lines and the value of N, the wavelengths of all the spectral lines of mercury spectrum are calculated using the formula,

$$\lambda = \frac{\sin\theta}{Nm} m$$

RESULT

The wavelengths of the prominent spectral lines of the mercury spectrum are calculated and given below:

Spectral lines	Experiment value (Å)	Standard value (Å)
Red	663 Å	6204
Yellow-2	5795 Å	5791
Yellow-1	5765 Å	5761
Bluish green	4920 Å	4916
Blue	4360 Å	4358
Violet	4065 Å.	4061

VIVA-VOCE QUESTIONS AND ANSWERS

1. **What is the unit of wavelength of light? Mention its value.**

   The unit of wavelength of light is Å, $1\ \text{Å} = 10^{-10}$ m.

2. **What is a plane transmission grating?**

   A plane transmission grating is made by ruling equidistant parallel lines on an optically transparent sheet of material. The line portion is opaque and the space between the lines is transparent.

3. **Is mercury light monochromatic? Why?**

   Mercury light is not monochromatic because it contains many colours. Hence, mercury light is composite light.

4. **What is a spectrum?**

   The different colours from mercury light (white light) constitute a spectrum.

5. **Define pure spectrum.**

   A spectrum is said to be pure if the colours in the spectrum are seen distinctly without overlapping.

6. **What is the type of diffraction in the present experiment?**

   Since the telescope receives parallel rays, the source and the image are assumed to be at infinite distances from the grating. Hence, the class of diffraction in the present experiment is called Fraunhofer class of diffraction.

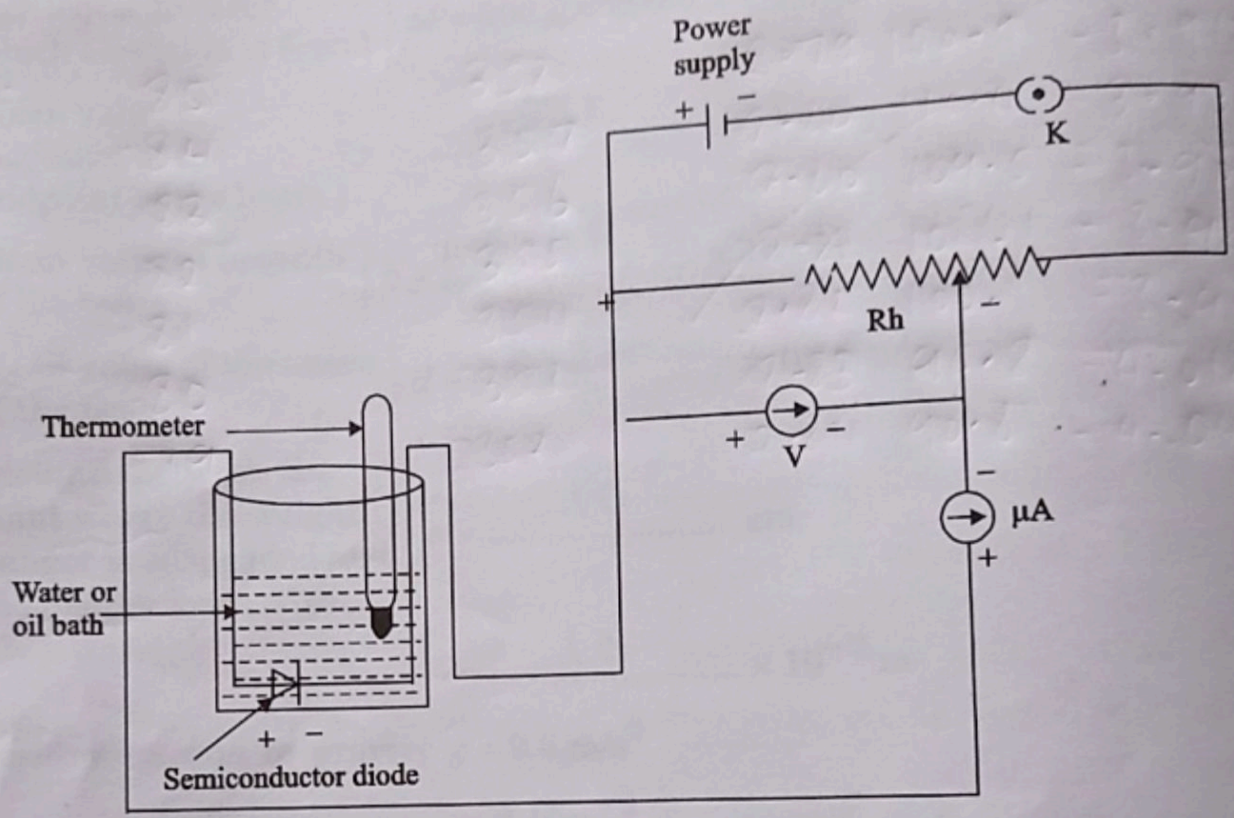


Fig. Band gap determination - circuit diagram

2. DETERMINATION OF BAND GAP OF A SEMICONDUCTING MATERIAL

Expt. No: 08

Date: 24 04 19

AIM

To determine the band gap of a given semiconducting material.

APPARATUS REQUIRED

1. A kit provided with a dc power supply (0 – 5V), a voltmeter, a micro-ammeter and connecting terminals
2. A given semiconductor diode
3. A water or oil bath with heating arrangement
4. A thermometer
5. Connecting wires

FORMULA

The band gap of the given semiconducting material,

$$E_g = 0.198 \times \text{ slope of the plot of } \log I_s \text{ versus } \frac{10^3}{T} \text{ eV}$$

PROCEDURE

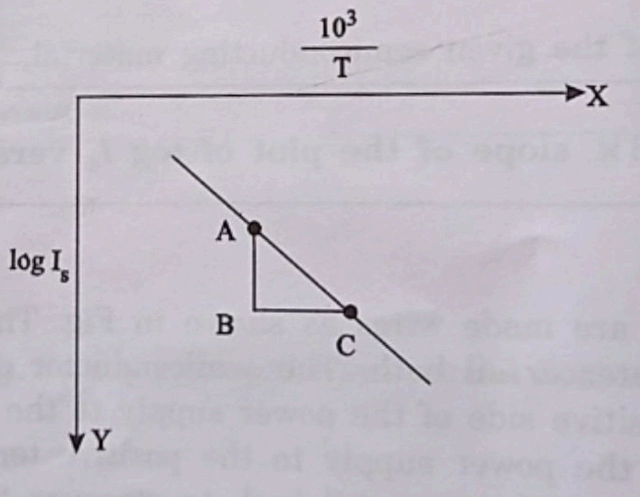
The connections are made wires as shown in Fig. The given semiconductor is immersed in a water or oil bath. The semiconductor diode is reverse biased by connecting the positive side of the power supply to the negative terminal and the negative side of the power supply to the positive terminal of the diode. A thermometer is placed in the water/oil bath to measure the temperature of the semiconductor diode.

The water/oil bath is heated using a heater up to the temperature 75°C. The heater is switched off. The DC power supply is switched on and the knob is adjusted to have any value between 0.5 V and 2.0 V in the voltmeter depending upon the type of semiconducting material. When the water/oil bath cools to the temperature 70°C the microammeter reading is noted. The microammeter reading is called reverse saturation current I_s. The microammeter readings are noted when the temperature of the water/oil bath cools to the temperature 65°C, 60°C, 55°C 50°C successively and the readings are tabulated. A graph is drawn taking $\log I_s$ along Y-axis and $\frac{10^3}{T}$ along X-axis. The plot will be a straight

(i) Observations

Sl.No.	Temperature of water/oil bath	Temperature of water/oil bath (°C + 273) = T	$\frac{10^3}{T}$	I_s	$\log(I_s)$
Unit	°C	K	K^{-1}	$\times 10^{-6}$ A	
1.	85	358	2.79	120.9	-3.917
2	84	357	2.80	115.4	-3.937
3	83	356	2.80	109.5	-3.960
4	82	355	2.81	104.1	-3.980
5	81	354	2.82	100.1	-3.999
6	80	353	2.83	95.8	-4.018
7	79	352	2.84	90.8	-4.041

(ii) A graph between $\frac{10^3}{T}$ and $\log I_s$



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

8. 73 346 2.890 38.1 -4.4190

9. 72 345 2.898 36.5 -4.4377

10. 71 344 2.906 34.7 -4.4596

line as explained below. The following equation shows the variation of reverse saturation current (I_s) with respect to temperature (T).

$$I_s = A \exp\left(\frac{-E_g}{kT}\right)$$

where A is a constant, E_g is the band gap of the semiconducting material and k is Boltzmann constant.

Taking logarithms on both sides,

$$\ln I_s = \ln A - \frac{E_g}{kT}$$

or $$2.303 \log I_s = 2.303 \log A - \frac{E_g}{kT}$$

Dividing throughout by 2.303

$$\log I_s = \log A - \frac{E_g}{2.303\, kT}$$

The gap between valence band and conduction band of a semiconducting material is known as band gap (E_g) and it is expressed in eV. Since $k = 1.38 \times 10^{-23}$ J/K, its value is to be divided by electronic charge e (= 1.6×10^{-19} coulomb) to convert the unit J/K into eV/K.

$$\log I_s = \log A - \frac{E_g}{\dfrac{2.303 \times 1.38 \times 10^{-23} \times T}{1.6 \times 10^{-19}}}$$

$$\log I_s = \log A - \frac{E_g \times \left(\dfrac{10^3}{T}\right)}{0.198}$$

The above relation shows that the graph between $\log I_s$ and $\frac{10^3}{T}$ is a straight line.

Hence, the slope of the straight line $= \frac{E_g}{0.198}$

$\therefore E_g = 0.198 \times$ slope of the straight line

The band gap is thus determined by calculating the slope of the straight line.

Result: The band gap of the given semi conducting material = 0.3762 eV

6. TO STUDY V-I CHARACTERISTICS OF A LIGHT DEPENDENT RESISTOR (LDR)

Aim

To measure the photoconductive nature and the dark resistance of the given light dependent resistor (LDR) and to plot the characteristics of the LDR.

Apparatus Required

LDR, Resistor (1 kΩ), ammeter (0 – 10 mA), voltmeter (0 – 10 V), light source, regulated power supply.

Formula

By ohm"s law, $V = IR$ (or) $R = V/I$ (ohm)

where *R* is the resistance of the LDR (i.e) the resistance when the LDR is closed. *V* and *I* represents the corresponding voltage and current respectively.

Principle

The photoconductive device is based on the decrease in the resistance of certain semiconductor materials when they are exposed to both infrared and visible radiation.

The photoconductivity is the result of carrier excitation due to light absorption and the figure of merit depends on the light absorption efficiency. The increase in conductivity is due to an increase in the number of mobile charge carriers in the material.

Procedure

1. The connections are given in as shown in Fig. 6.1.
2. The light source is switched on and made to fall on the LDR.
3. The corresponding voltmeter and ammeter readings are noted.
4. The procedure is repeated by keeping the light source at different distances from the LDR.
5. A graph is plotted between resistance and distance of LDR from the light source.
6. The LDR is closed and the corresponding voltmeter and ammeter readings are noted. The value of the dark resistance can be calculated by Ohm"s law.

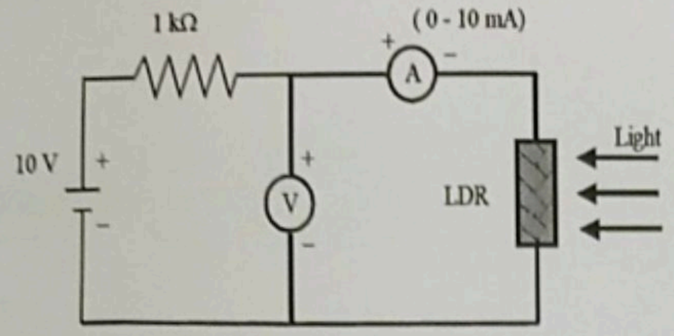


Fig. 6.1 Circuit diagram

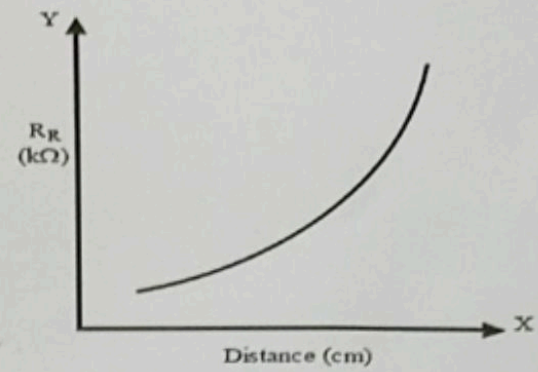


Fig. 6.2 Model graph

Observation

Voltmeter reading when the LDR is closed = ..1... V
Ammeter reading when the LDR is closed = ..1m A
Dark resistance = R = *V/I* = ..500 Ohm

Table 6.1 To determine the resistances of LDR at different distances

S.No	Distance (cm)	Voltmeter reading (V) volt	Ammeter reading (I) mA	R_R kΩ
1.	50	4.5	120	51
2.	40	3.5	110	35
3.	30	2.5	100	22
4.	20	1.5	90	11

Result

1. The characteristics of LDR were studied and plotted.
2. The dark resistance of the given LDR = 500 ohm

3. ZENER DIODE

1. AIM:

1. To plot the V-I characteristics of ZENER diode under forward and reverse bias conditions.
2. To find ZENER voltage, forward bias resistance & reverse bias resistance after ZENER Breakdown.

2. i. EQUIPMENTS REQUIRED:

1. Bread Board
2. Connecting wires
3. Volt meter (0 - 20V)
4. Ammeter (0 - 20 mA), (0 – 20mA)
5. Regulator DC power supply.

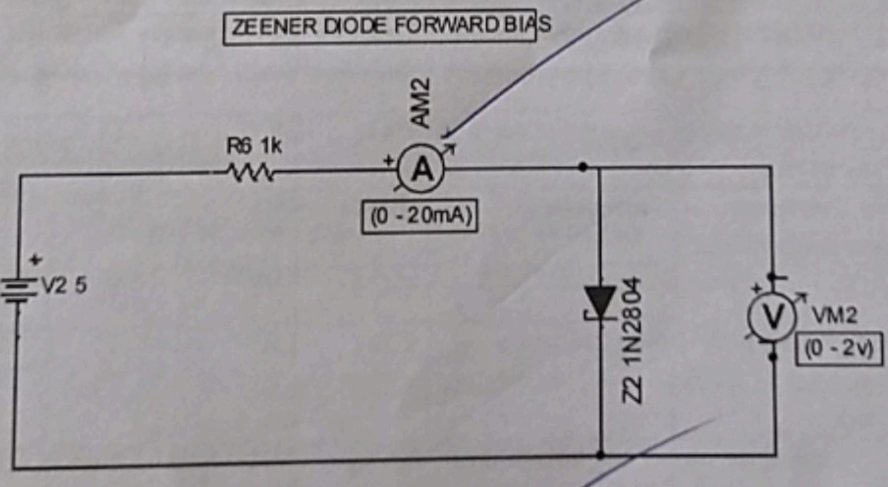
ii. COMPONENTS REQUIRED:

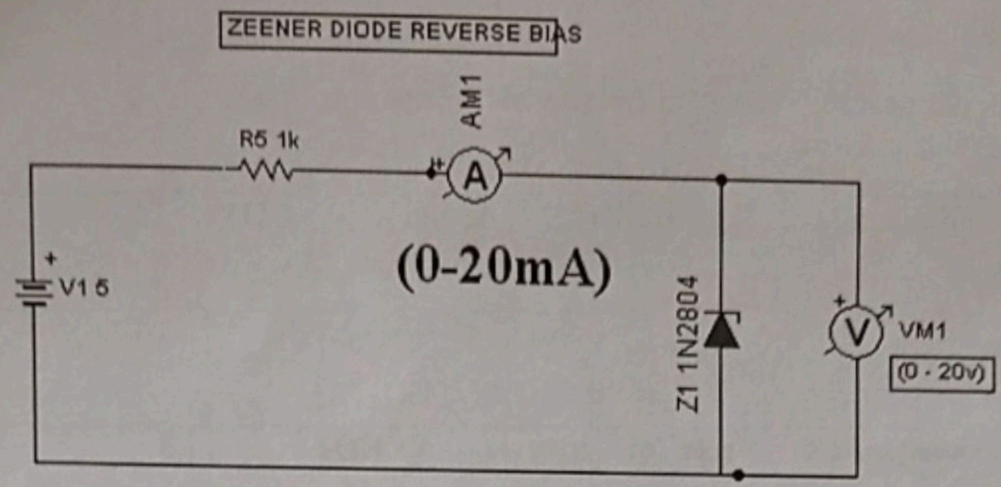
1. Zener diode (IN 2804)
2. Resistor (1kΩ)

3. THEORY:

Zener diode acts as normal PN junction diode. And during reverse bias as reverse voltage reaches breakdown voltage diode starts conducting. To avoid high current, we connect series resistor with it. Once the diode starts conducting it maintains constant voltage across it. Specially made to work in the break down region. It is used as voltage regulator.

4. CIRCUIT





5. PROCEDURE:

Forward Bias:

1. Connect the circuit as per the circuit diagram.
2. The DC power supply is increased gradually in steps of 1 volt.
3. Corresponding Voltmeter and Ammeter readings are noted and the V-I characteristics are plotted with zener voltage on X axis and current along the Y axis.
4. Break voltage is found and the break down resistance of zener diode is calculated.

Reverse Bias:

1. Connect the circuit as per the circuit diagram.
2. The DC power supply is increased gradually in steps of 1 volt.
3. Corresponding Voltmeter and Ammeter readings are noted and the V-I characteristics are plotted with zener voltage on X axis and current along the Y axis.
4. Break voltage is found and the break down resistance of zener diode is calculated

6. OBSERVATION TABLE

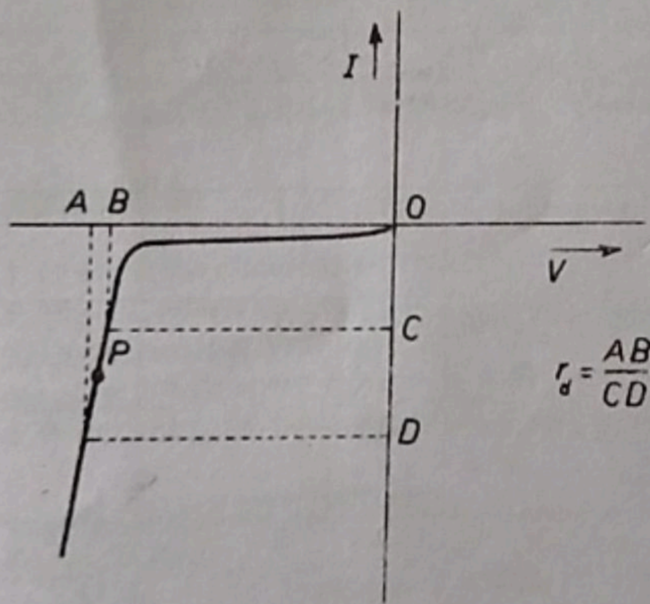
Forward bias

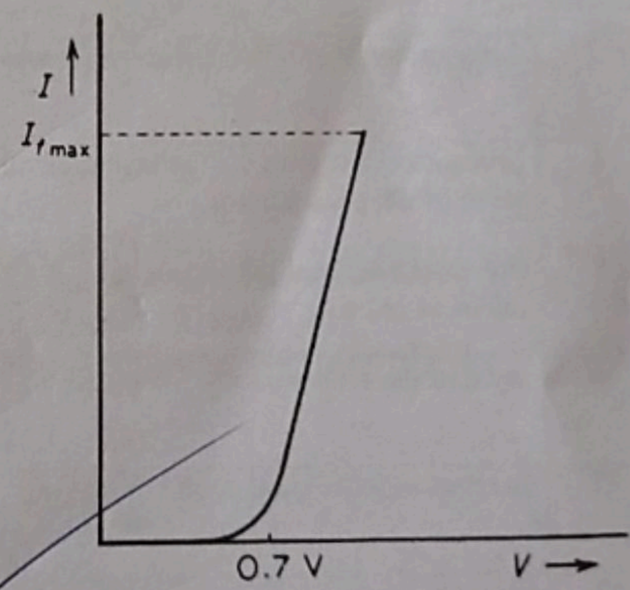
Sl No	Voltmeter reading In volt	Ammter reading In mA
1.	0.15	0.01
2.	0.25	0.01
3.	0.30	0.01
4.	0.34	0.01
5.	0.45	0.01
6.	0.57	0.01
7.	0.65	0.33
8.	0.70	2.11
9.	0.75	11.50
10.	0.76	17.85

Reverse bias

Sl. No	Voltmeter reading In volt	Ammeter reading In mA
1.	1.07	0.01
2.	2.26	0.01
3.	3.08	0.01
4.	4.07	0.01
5.	5.35	0.01
6.	6.40	0.01
7.	6.60	0.01
8.	6.66	0.60
9.	6.70	8.20
		19.25

GRAPH





7. INTERFERENCE:

Zener diode is having a very sharp break down. That is for constant voltage different currents can flow through it Zener diode can be operated in reverse bias.

8. PRECAUTION

1. It is preferable to use digital Multimeter in place of analog voltmeter
2. Maximum current should not exceed the value which is given on the data sheet.

Result:-

(i) Zener voltage = 0.6V

(ii) Forward bias resistance = [illegible]1 Ω

(iii) Reverse bias resistance = 0.1 Ω

Bharath

INSTITUTE OF HIGHER EDUCATION AND RESEARCH

(Declared as Deemed-to-be-University under section 3 of UGC Act 1956)

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RECORD NOTE BOOK

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Branch: ECE

Subject: Physics

Bharath

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Course......B.TECH...... Branch......ECE......

Year......first...... Semester......2nd......

Register No. U18EC076

Certified to be the bonafide Record of work done by the above student in the ......Physics practical...... laboratory during the 1st & 2nd ......Semester in the Academic year 2018 - 2019.

Signature of the Lab-in-charge

Signature of the Head of Dept.

Submitted for the practical examination held on......17-05-2019......

Internal Examiner

External Examiner

INSTRUCTIONS FOR MAINTAINING THE RECORD NOTE BOOK

1. The Record should be written neatly in ink on the pages of the right hand side and the diagrams /drawings to be drawn on the pages of the left hand side in pencil.

2. Every Experiment should begin on a new page.

3. The right hand side pages of the record should contain:

   i. SI. No. and date of performance of the Experiment in the margin at the top.

   ii. Experiment No. and the title of the Experiment on the first line followed by

   iii. Aim of the Experiment.

   iv. A list of apparatus required.

   v. Description of the apparatus.

   vi. Theory of the Experiment in brief.

   vii. Inference of the result.

4. The left hand side pages of the Record should contain :

   i. Neat sketches of apparatus used and full page graphs wherever possible.

   ii Diagrams of Electrical connections neatly drawn.

   iii. Observation (to be entered in a tabular form neatly, wherever possible)

   iv. A detailed account of manipulation.

CONTENTS

SL. No.	DATE	NAME OF THE EXPERIMENT	PAGE No.	MARKS	REMARKS
01	18-09-18	Determination of Wavelength of laser light	01-03	10	[illegible]
02	24-09-18	Determination of Particle Size Using laser	04-06	10	[illegible]
03	9-10-18	Determination Of Acceptance angle of an Optical fibre	07-09	10	[illegible]
04	02-02-19	Determination of Thickness of a thin wire air wedge method	10-12	10	[illegible]
05	06-03-19	Determination of Velocity of Sound and Compressibility of Liquid - Ultrasonic Interferometer	13-16	10	[illegible]
06	13-03-19	Determination Of Specific resistance of a given Coil of wire - Carey Foster's Bridge	17-20	10	[illegible]
07	23-03-19	Determination of Specific resistance of wire -			

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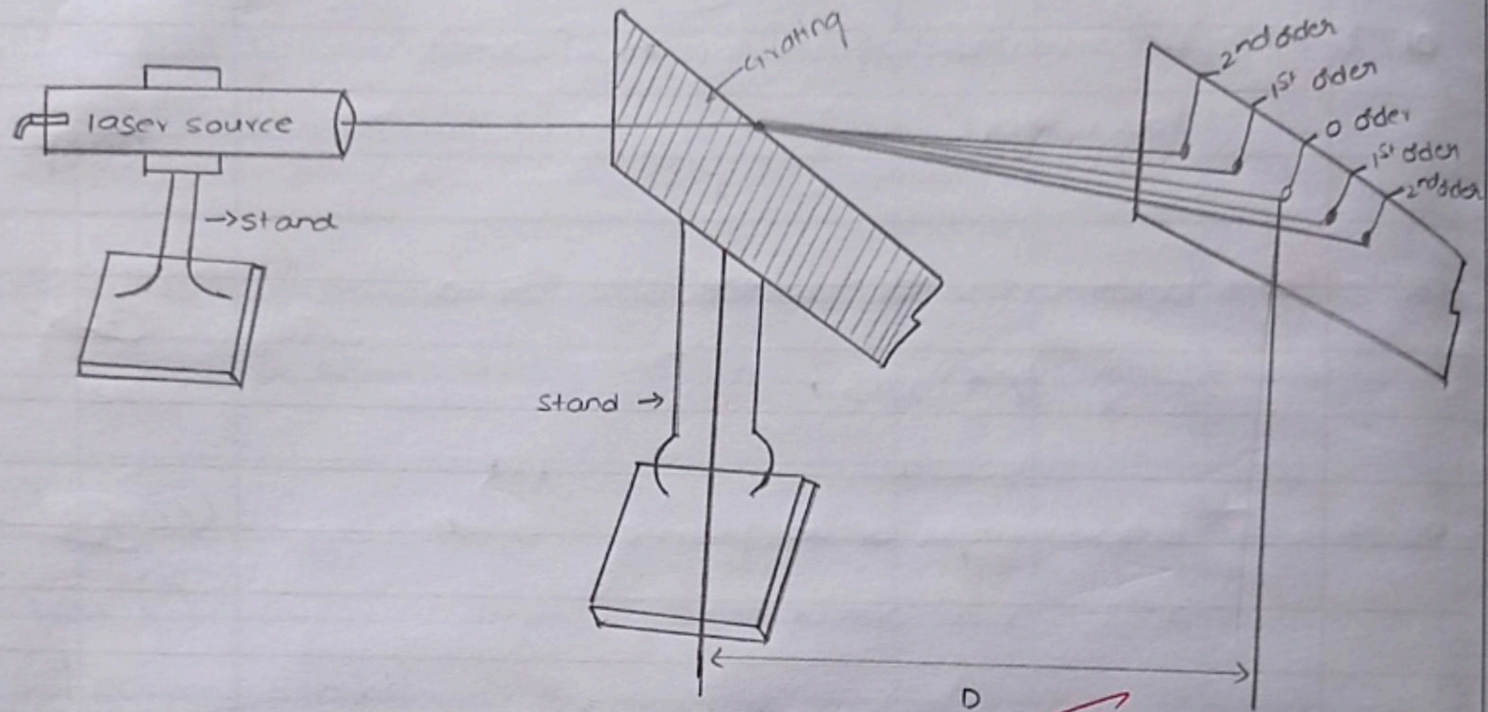
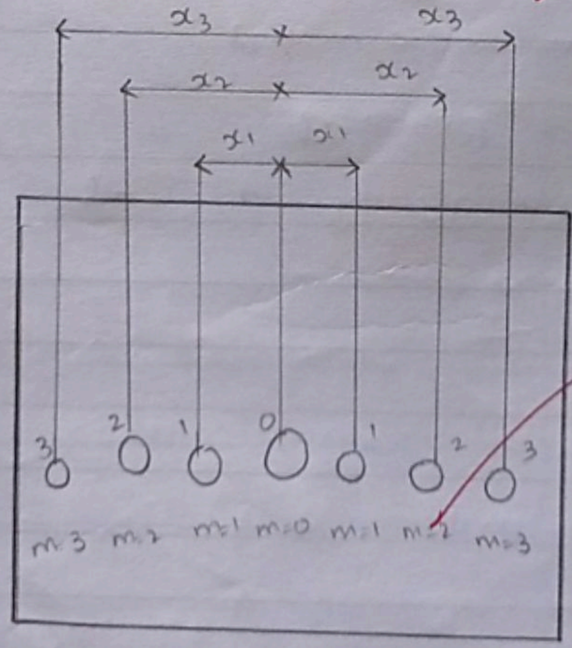
SL. No.	DATE	NAME OF THE EXPERIMENT	PAGE No.	MARKS	REMARKS
07	20-03-19	Determination of wavelength of mercury Spectrum Using grating	21-24	10	
08	21-03-19	Determination of band gap of a Semiconducting Material	25-28	10	
09	22-03-19	V-I characteristics of LDR	29-31	10	
10	23-03-19	Determination of Zener diode	32-35	10	

Completed

fig(a) - Determination of wavelength (λ) of laser light - laser grating





fig(b) Diffraction pattern

DETERMINATION OF WAVELENGTH OF LASER LIGHT

Aim:-

To determine the wavelength of the given laser light using grating.

Apparatus required:-

* laser light source
* Grating
* screen
* Half meter scale.

formula:-

The wavelength of the given laser light,

$$\lambda = \frac{\sin\theta}{Nm} \; m$$

explanation of symbols:-

Symbol	explanation	unit
θ	Angle of diffraction.	degree
m	order of diffraction spots.	
N	Number of lines per meter in grating	lines/m.

i, calculation of number of lines per metre (N) in grating.

laser grating normally consists 2500 lines per inch

1 inch = 2.54 cm = 2.54×10^{-2} m.

2.54×10^{-2} m contains 2500 lines

1m contains $\frac{2500 \times 10^2}{2.54}$ = 98425 lines

∴ N = 98425 lines/m.

ii, Determination of wavelength of laser light.

Number of lines/m in the grating (N) = 10^5 lines/m

Distance between the grating and screen = 45.5 cm

S NO	order of diffraction	Distance of different spots from the central Spot (xcm)			$\tan\theta = x_m/D$	$\theta = \tan^{-1} x_m/D$	$\lambda = \frac{\sin\theta}{Nm}$ m
		left	right	mean			
unit	(m)	cm	cm	cm.		degree	m.
1.	1	2.9	2.9	2.9	0.0637	3.6448	6.355×10^{-7}
2.	2	5.9	5.9	5.9	0.1296	7.3843	6.426×10^{-7}
3.	3	8.9	8.9	8.9	0.1956	11.0673	6.396×10^{-7}
4.	4	12.2	12.2	12.2	0.2681	15.0080	6.473×10^{-7}
5.	5	15.4	15.4	15.4	0.3384	18.6958	$6 \times 4108 \times 10^{-7}$
6.	6						

mean = 6.412×10^{-7}

= 6412 A^0

procedure:-

The experimental set-up for the determination. of the wavelength of the given laser light using grating is shown in fig(a). The laser source is kept horizontally extreme care should be taken to avoid direct exposure of eyes to laser light. The grating is held normal to the laser beam. A screen is placed on other side of grating.

laser light source is switched on for the normal incidence of laser beam on the grating is adjusted for such that the reflected laser beam from the grating coincides with the beam coming out of the laser source. Now the diffraction pattern in the form of circular spots is observed on the screen. The diffraction pattern consists of central spot followed by a number of spots on either side of the central gets as shown in fig(b). The different spots etc. The distance (xm) of the different spots on either side from the central spot are measured using scale. The distance between the grating and screen (D) is also measured.

The value θ is calculated using the following expression,

$$\theta = \tan^{-1} x_m/D$$

and wavelength of the given laser light is calculated using the formula,

$$\lambda = \frac{\sin\theta_m}{N m}$$

Calculation

1) $\lambda = \frac{\sin\theta}{Nm}$

$\lambda = \frac{\sin(3.644)}{10^5 \times 1} = \frac{0.6355}{10^5} = 6.355 \times 10^{-7}$ Åm

2) $\lambda = \frac{\sin(7.3843)}{10^5 \times 2} = \frac{0.12852}{10^5 \times 2} = 6.426 \times 10^{-7}$ m

3) $\lambda = \frac{\sin(11.0673)}{10^5 \times 3} = \frac{0.19196}{10^5 \times 3} = 6.396 \times 10^{-7}$ m

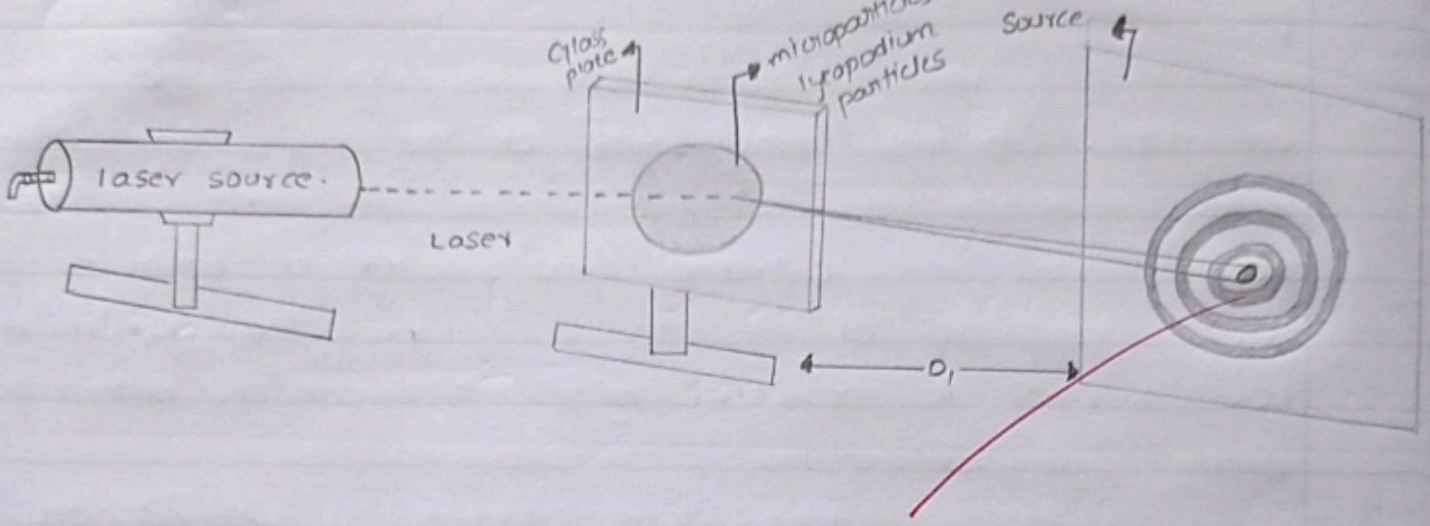
4) $\lambda = \frac{\sin(15.0080)}{10^5 \times 4} = \frac{0.25895}{10^5 \times 4} = 6.473 \times 10^{-7}$ m

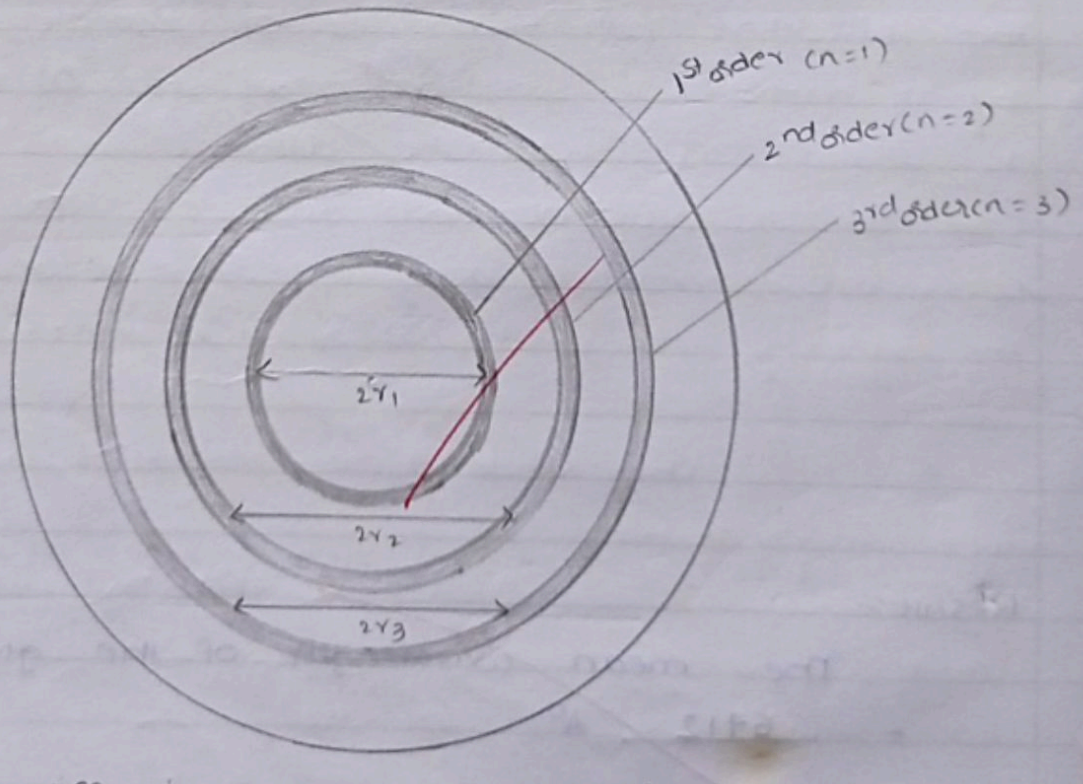
5) $\lambda = \frac{\sin(18.6958)}{10^5 \times 5} = \frac{0.32054}{10^5 \times 5} = 6.4108 \times 10^{-7}$ m.

Result:-

The mean wavelength of the given laser light
= 6412 A°

Fig(a):- experimental st-up to produce diffraction circular rings for determing the particle size.





fig(b). diffraction pattern - circular rings

DETERMINATION OF PARTICLE SIZE USING LASER

Aim:-

To determine the size of the given microparticles present in the lycopodium power using laser light

Apparatus required:-

* Laser source
* Lycopodium powder with fine microparticles
* Glass plate
* screen
* Half meter scale.

formula:-

The size (diameter) of the given particles

$$d = \frac{n \lambda D_1}{x_n} \text{ metre.}$$

explanation of symbols:-

Symbol	explanations	unit.
n	order of diffraction	
λ	wavelength of laser light used	metre.
D_1	distance b/w the glass plate and screen	metre
x_n	Radii of different order dark rings	metre.

Determination of particle size:-

wavelength of laser light used $\lambda = 6900 \times 10^{-10}$ m

SNO	Distance b/w the screen and glass plate	order of circular rings	Diameter of n^{th} dark ring	Radii of n^{th} dark ring	particle size $d = \frac{n\lambda D_1}{x_n}$
unit	cm	–	cm	cm	m
1	10.5	1	$20 (2x_1)$	$10 (x_1)$	$7,245 \times 10^{-10}$
2		2	$40 (x_2)$	$20 (x_2)$	$7,245 \times 10^{-10}$
3					
1	18.5	1	$30 (2x_1)$	$15 (x_1)$	$8,530 \times 10^{-10}$
2		2	$68 (2x_2)$	$34 (x_2)$	$7,508 \times 10^{-10}$
3					
1	23	1	$40 (2x_1)$	$20 (x_1)$	$7,935 \times 10^{-10}$
2		2	$80 (2x_2)$	$40 (x_2)$	$7,935 \times 10^{-10}$
3					

Mean = 7.7298 μm.

calculation:-

i) $D_1 = 10.5$ cm $\lambda = 6900 \times 10^{-10}$ m.

1. for $n = 1$ $x_n = x_1 =$ cm $= 10$ cm.

$$d = \frac{\lambda \times D_1}{x_1} = \frac{1 \times 6900 \times 10^{-10} \times 10.5 \times 10^{-2}}{10 \times 10^{-2}} = 7245 \times 10^{-10} \text{ m}.$$

procedure:-

The experimental set-up to produce diffraction pattern (circular rings) for determining the particle size is shown in fig (a) The glass plate is cleaned well and fine lycopodium powder of particle size in the range of micrometer is sprinkled uniformly over the glass plate. The glass plate is placed between the laser source and the screen. The laser source is switched on and light is made to fall on the glass plate. Now, the laser gets diffracted by the particles present on glass plate.

The distance between the glass plate and the screen is adjusted until a clear image of circular rings pattern is obtained on the screen as shown in fig(b) The distance between the glass plate and the screen is measured as D_1. The diameters of the dark rings of different orders ($n = 1, 2, 3 \ldots$) are measured as $2x_1, 2x_2, 2x_3 \ldots$ using a half metre scale. The radii of the dark rings are then calculated as $x_1, x_2, x_3 \ldots$ The particle size is calculated using the formula.

$$d = \frac{n \lambda D_1}{x_n} \text{ m}$$

The experiment is repeated for various values as D_1 and the mean value of particle size is calculated

2. for $n = 2$

$$d = \frac{2\lambda \times D_1}{x_2} = \frac{2 \times 6900 \times 10^{-10} \times 10.5 \times 10^{-2}}{2.0 \times 10^{-2}} = 7245 \times 10^{-10}$$

(i), calculation

$n = 1$, $d = 18.5$, $x_n = 15$

$$d = \frac{1 \times 18.5 \times 6900 \times 10^{-10}}{15}$$

$= 8.510 \times 10^{-10}$ m.

(ii), $n = 2$, $d = 18.5$ $x_n = 34$

$$d = \frac{2 \times 18.5 \times 6900 \times 10^{-10}}{34}$$

$= 7.50083 \times 10^{-5}$ m.

(ii), (i), $n = 1$ $d = 23$, $x_n = 20$

$$d = \frac{1 \times 23 \times 6900 \times 10^{-10}}{20}$$

$= 7,935 \times 10^{-5}$ m

(ii), $n = 2$, $d = 23$, $x_n = 40$

$$= \frac{2 \times 23 \times 6900 \times 10^{-10}}{40}$$

$= 7935 \times 10^{-10}$ m.

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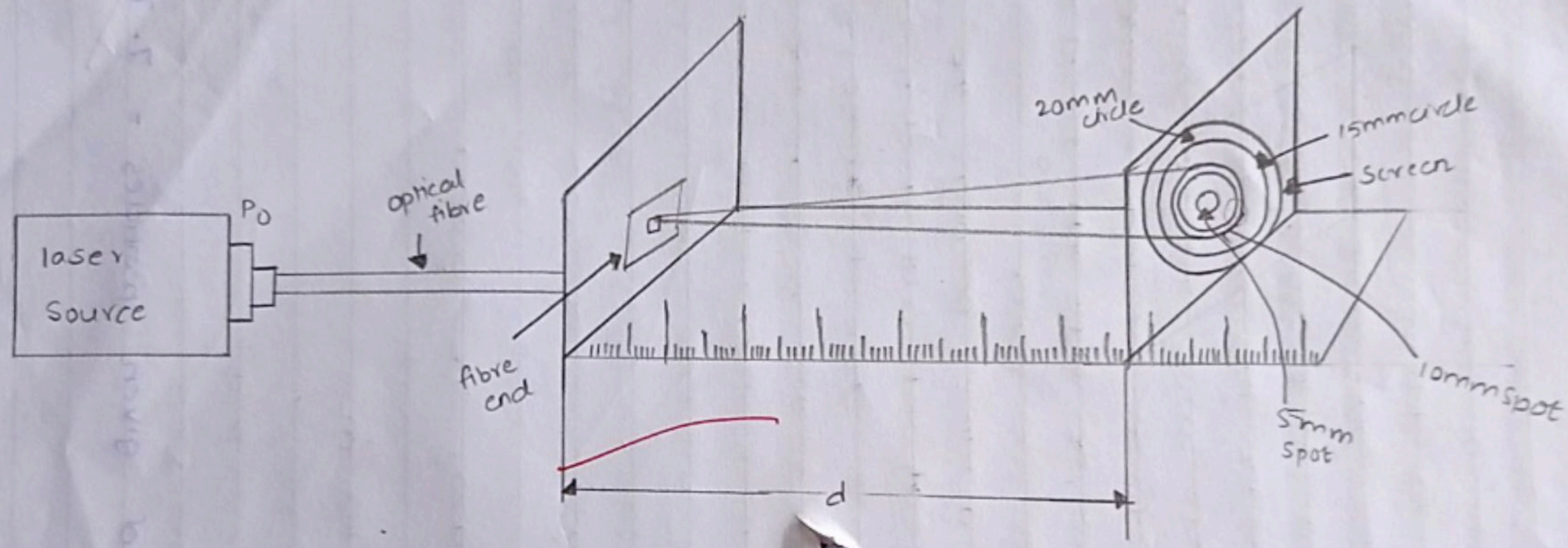
Result:-

The average size of given particles = 7.7298 μm



Fig(a): experimental set-up for the measurement of numerical aperture and Acceptance angle.

DETERMINATION OF ACCEPTANCE ANGLE OF A OPTICAL FIBRE.

Aim:-

To determine the numerical sprecture and acceptance angle of given optical fibre.

Apparatus required:-

* laser light source
* optical fibre cable.
* Numerical operature jig
* Screen with concentric circles
* half metre scale.

formula:-

i, Numerical aperature; $NA = \sin\theta_a = \frac{r_n}{\sqrt{r_n^2 + d_n^2}}$

ii, acceptance angle ; $\theta_a = \sin^{-1} NA$ degree.

explanation of Symbols:-

Symbol	explanation	unit
r_n	Radius of the n^{th} illuminated circular image	mm
d_n	Distance b/w the fibre end and the screen with concentric circular image	mm

Determination of numerical aperature and acceptance angle

SNO	order (n)	Distance b/w the fibre and screen(d_n)	Radius of circular image (r_n)	numerical aperature $NA = \frac{r_n}{\sqrt{r_n^2+d_n^2}}$	Acceptance angle $\theta_a = \sin^{-1} NA$
unit		mm	mm		degree
1	1	15	2.5	0.164	9.43°
2	2	22	5	0.221	12.76°
3	3	24	7.5	0.298	17.33°
4	4	29	10	0.326	19.02°
5	5	31	12.5	0.373	21.9°
6	6	39	15.0	0.358	20.97°

Mean = 0.285 mean = 16.65de

procedure:-

The experimental set-up for the measurement of numerical apurature and acceptance angle of a given optical fibre is shown in fig. one end of the optical fibre is connected to a laser source and the other end is connected to a numerical Apurature jig (NA jig). The NA jig is provided with a screen consisting of concentric circles. The successive concentric circles are marked with increasing diameters starting from the first circle as 5mm, 10mm, 15mm etc. A horizontal scale is also provided to measure the distance b/w the fibre end and the screen.

The laser source is switched on. By adjusting the position of the screen, the first circle of diameter 5mm is uniformly illuminated with red patch of light. The radius of first circle is measured as r_1 using a half meter scale and the corresponding distance of the screen from the fibre end is measured as d_1 using the horizontal scale. Then, the numerical Apurature (NA) and the acceptance Angle (θ_a) are calculated using the following formula.

$$NA = \frac{r_1}{\sqrt{r_1^2 + d_1^2}}$$

$$\left[\because NA = \frac{r_n}{\sqrt{r_n^2 + d_n^2}} \quad \text{Here } n=1 \right]$$

and $\theta_a = \sin^{-1} NA$ degree.

The experiment is repeated by moving the screen so that the remaining concentric circles of diameters 10mm, 15mm, 20mm etc. are illuminated successively with uniform brightness. The radii r_2, r_3, r_4 etc. of the circles and the corresponding distances d_2, d_3, d_4 of the screen from the fibre end are measured respectively.

calculation:-

$$N_1 = \frac{r_1}{\sqrt{r_1^2 + d_1^2}} = \frac{2.5}{\sqrt{(2.5)^2 + (15)^2}} = 0.164 \Rightarrow \theta = 9.43^\circ$$

$$N_2 = \frac{r_2}{\sqrt{r_1^2 + d_1^2}} = \frac{5}{\sqrt{(5)^2 + (15)^2}} = 0.221 \Rightarrow \theta = 12.76^\circ$$

$$N_3 = \frac{r_3}{\sqrt{r_3^2 + d_3^2}} = \frac{7.5}{\sqrt{(7.5)^2 + (15)^2}} = 0.298 \Rightarrow \theta = 17.35^\circ$$

$$N_4 = \frac{r_4}{\sqrt{r_4^2 + d_4^2}} = \frac{10}{\sqrt{(10)^2 + (15)^2}} = 0.326 \Rightarrow \theta = 19^\circ$$

$$N_5 = \frac{r_5}{\sqrt{r_5^2 + d_5^2}} = \frac{12.5}{\sqrt{(12.5)^2 + (15)^2}} = 0.373 \Rightarrow \theta = 21.9^\circ$$

$$N_6 = \frac{r_6}{\sqrt{r_6^2 + d_6^2}} = \frac{15}{\sqrt{(15)^2 + (15)^2}} = 0.358 \Rightarrow \theta = 20.9^\circ$$

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Then $NA = \frac{r_2}{\sqrt{r_2^2 + d_2^2}}$ (Here n=2)

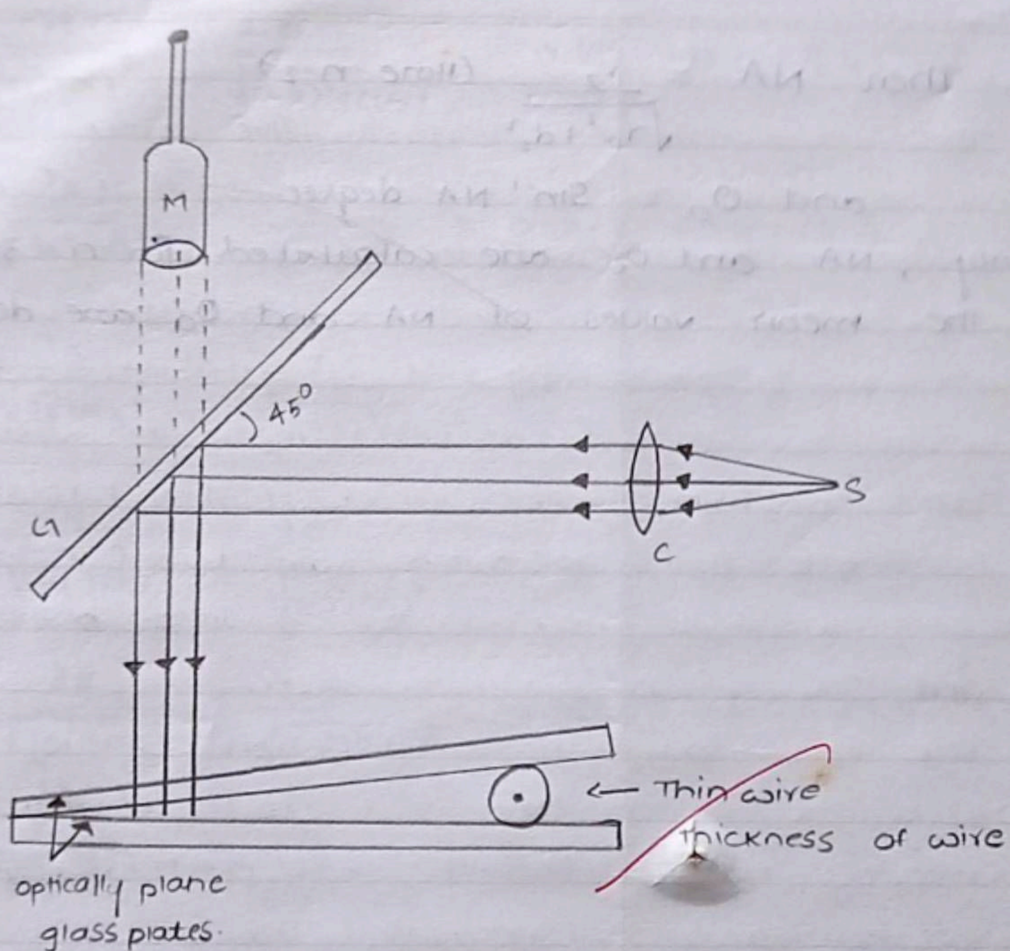
and $\theta_a = \sin^{-1} NA$ degree

Similarly, NA and θ_a are calculated for n = 3,4,5 etc and the mean values of NA and θ_a are determined

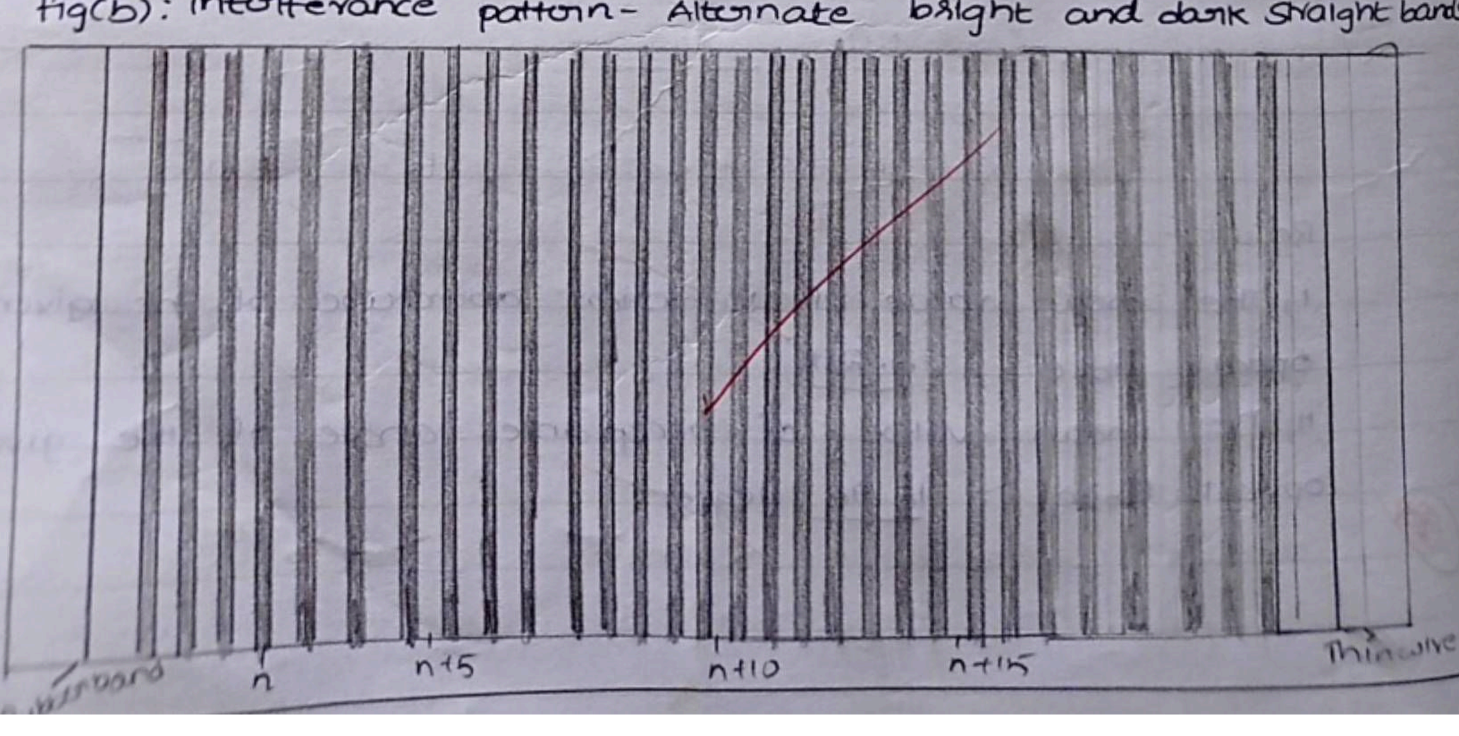
Result:-

i, The mean value of Numerical aperature of the given optical fibre = 0.285

ii, The mean value of acceptance angle of the given optical fibre = 16.90 degrees fig(a): Air-wedge - experimental set-up.



fig(b): interferance pattern - Alternate bright and dark straight bands



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DETERMINATION OF THICKNESS OF A THIN WIRE AIR WEDGE METHOD

Aim:-

TO determine the thickness of a given thin wire by forming interferance frenges using air-wedge method

Apparatus required:-

* travelling microscope.
* Sodium vampour lamp
* Two Optically plane rectangular glass plates
* condensing lens
* Reading lens
* Given thin wire.

formula:-

The thickness of the given thin wire, $t = \frac{\lambda l}{2B}$ m.

explanation of the Symbols:-

Symbol	explanation	unit.
λ	wavelength of Sodium light	metre
l	dis b/w edge of contact and wire	metre
B	Bandwidth	metre.

i) least count of the travelling microscope :-

least count = 1 MSD − 1 VSD.

= 20 MSD = 1 cm

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

50 MSD = 49 MSD

= 49×0.05 cm

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

LC = (0.05 − 0.49) cm = 0.001 cm.

ii) Determination of bandwidth :-

LC = 0.001 cm.

SNo	order of the dark band	microscope readings				width of 15 dark bands	Bandwidth
		MSR	VSC	VSR = VSC×LC	TR = MSR + VSR		
Unit		cm	div	cm	cm	cm	cm
1	n	7.45	4	4×0.001	7.404	0.049	0.098
2	n+5	7.35	5	5×0.001	7.355	0.049	0.098
3	n+10	7.30	6	6×0.001	7.306	0.055	0.11
4	n+15	7.25	1	1×0.001	7.251	0.048	0.096
5	n+20	7.20	3	3×0.001	7.203	0.048	0.096
6	n+25	7.15	4	4×0.001	7.154	0.049	0.098
7	n+30	7.10	2	2×0.001	7.102	0.052	0.0104
8	n+35	7.05	7	7×0.001	7.057	0.045	0.009

Mean (β) = 0.017 cm

$= 0.017 \times 10^{-2} m$

procedure:-

Two optically plane glass plates are held firmly together at one end with the help of a rubber band The given wire is placed at the other end. Now, an air-film of varying thickness is formed between the two glass plates. Thus arrangement is called air-wedge. The experimental set-up is shown in fig(a)

light from a Sodium lamp(s) is rendendred parllel by a convex lens (c). The parllel rays of light fall on a glass plate(G) linclined at 45° to the horizontal bed of a travelling microscope. The light reflected from the glass plate falls vertically on the air-wedge. interferance takes place between the rays of light reflected from top and lower surfaces of the air film between ~~the~~ rays the light plane glass plates. Alternate bright and dark straight bands are formed depending upon the path difference between the light rays. The microscope is focussed on the interferance bands. The fine adjustment screw at the side. The main scale reading and the corresponding vernier scale coincidence are noted. The total microscope reading is then calculated

$$TR = (MSR + VSR)\ cm.$$

$$\text{where } VSR = (VSC \times LC)$$

The observations are repeated for n+5, n+10, n+20.. dark bands respectively by adjusting fine adjustment screw. from this the width of 15 dark bands is determined and hence the bandwidth β is calculated. The distance b/w the rubber band and wire is measured using the travelling microscope. The wavelength (λ) of sodium light iii, To measure the distance b/w the rubber band and given wire

LC = 0.001cm

position	microscope reading				$l = H_2 - H_1$
	MSR	VSC	VSR = VSC×LC	TR = MSR+VSR	cm
Unit	cm	div	cm	cm	
Rubber band Given wire					3.42

iv, calculation:-

The mean bandwidth (β) = 0.076 cm.

= 0.076×10^{-2} m

The dis b/w the rubber band and given wire } l = 3.42 cm

= 3.42×10^{-2} m

The wavelength of sodium light $\lambda = 5893 \times 10^{-10}$ m

The thickness of the given wire

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

$$= \frac{5893 \times 10^{-10} \times 3.4 \times 10^{-2}}{2 \times 0.076 \times 10^{-2}}$$

$$= 1.10 \cdot 391 \times 10^{-10} \text{ metre}$$

20036.2

0.13 × 5893 × 10⁻¹⁰

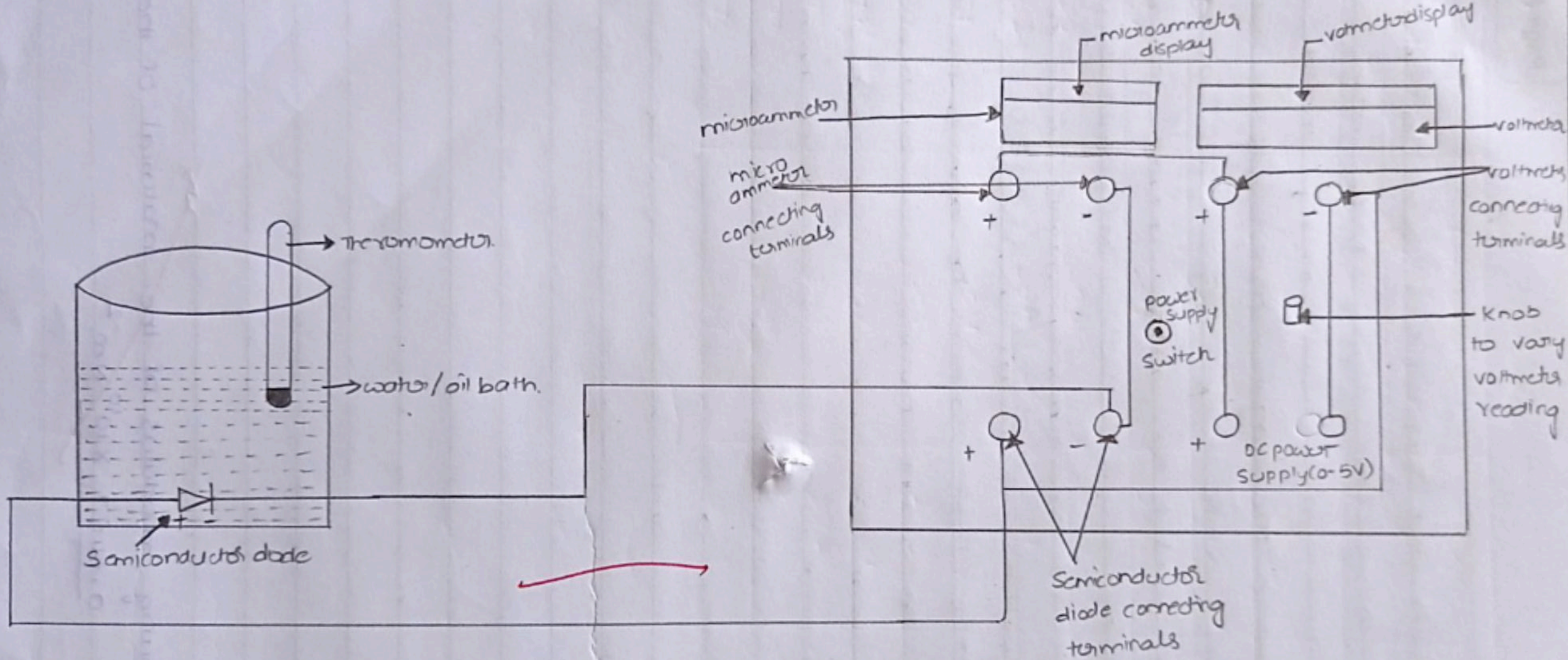
5893 × 0.1

is taken from the data given at the end of book
The thickness of given thin wire is calculated using formula

Result:-

The thickness of the given thin wire = ~~7.80~~ 7.70 metre.
391 × 10^{-5}

fig(a): Band gap determination- circuit diagram.



Red terminals- positive terminals

Black terminals – negative terminals

DETERMINATION OF BAND GAP OF A SEMICONDUCTING MATERIAL

Aim:-

To determine the band gap of a given semiconducting material

Apparatus required:-

* A kit provided with dc power supply (0-5v), a voltmeter
* A micro-ammeter, connecting terminals
* A given semiconductor diodes.
* A water or oil bath with heating arrangment
* A thermometer
* A connecting wires

formula:-

The band gap of the given semiconducting material

$E_g = 0.198 \times$ slop of the plot of log I_g versus $10^3/T$ eV

explanation of symbols :-

Symbol	explanations	unit
I_g	Saturation Reverse current	micro-ampere
T	Absolute temperature of water or oil bath	Kelvin

1) observations

S NO	Temp of water/oil bath	Temp of water/oil bath $(0^\circ C + 273) = T$	$10^3/T$	I_S	$\log I_S$
unit	$^\circ C$	K	K^{-1}	μA	
1.	85	358	2.79	120.9	-3.917
2.	84	357	2.80	115.4	-3.937.
3	83	356	2.80	109.5	-3.960
4	82	355	2.81	104.1	-3.980
5	81	354	2.82	100.1	-3.999
6	80	353	2.83	95.8	-4.018
7	79	352	2.84	90.8	-4.041
8	78	351	2.85	85.9	-4.066
9	77	350	2.86	80.8	-4.092
10	76	349	2.87	71.3	-4.111

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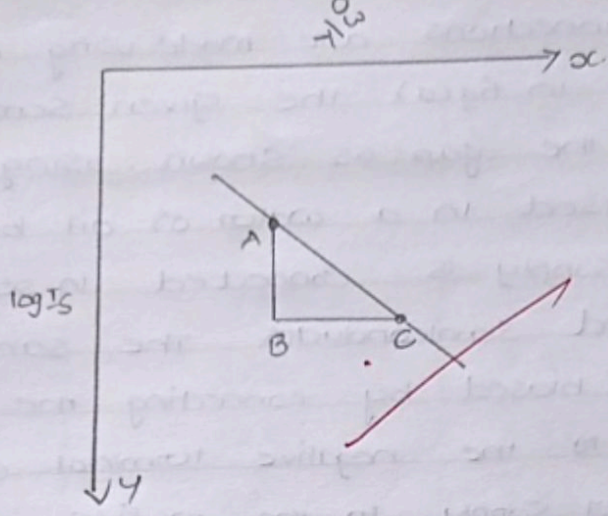
procedure:-

The connections are made using connecting wires as shown in fig(a). The given Semiconductor is connected in the gap as shown. using conning wires and immersed in a water or oil bath. The given dc power supply is connected in series with a microammeter and semiconductor. The semiconductor diode is reverse biased by connecting the positive side of the power supply to the negative terminal and the negative side of the power supply to the positive terminal of the diode. A thermometer is placed well within the water/oil bath to measure the temperature of the semiconductor diode.

A water/oil bath is heated upto the temperature 75°c The heater is switched off. The DC power supply is switched on and the knob is adjusted to have any value between 0.5V and 2.0V in the voltmeter depending upon the type of semiconducting material. when the water/oil bath cools to the temperature 70°c the microammeter reading is noted. The micro ammeter reading is called reverse Saturation current I_s. The microammeter readings are noted when the temperature of water/oil bath cools to the temperature 65°c, 60°c, 55°c, 50°c Successively and the readings are tabulated. A graph is taken taking $\log I_s$ along y-axis and $10^3/T$ along x-axis. The plot will be a straight line as explained below. The following Equations shows the variations of reverse saturation current (I_s) with respect to temperature(T) ii, The graph between $10^3/T$ and log Is.



iii, calculation:-

$$Eg = 0.198 \times 1.9$$
$$= 0.3762\,eV$$

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$$I_S = A \exp\left[-E_g/_{KT}\right]$$

where A is a constant, E_g is band gap of semi conducting material and K is Boltzman constant.

Taking log on both sides.

$$\ln I_S = \ln A - E_g/_{KT}$$

$$2.303 \log I_S = 2.303 \log A - E_g/KT$$

Dividing throughout by 2.303

$$\log I_S = \log A - E_g/_{2.303KT}$$

The gap between valence band and conduction band of a semiconducting material is known as band gap (E_g) and it is expressed in eV. since $K = 1.38 \times 10^{-23}$ J/K its value is to be divided by electronic charge $e = (1.6 \times 10^{-19}$ coloumb) to convert the unit J/K into eV/K

$$\log I_S = \log A - \frac{E_g}{\frac{2.303 \times 1.38 \times 10^{-23} \times T}{1.6 \times 10^{-19}}}$$

$$\log I_S = \log A - \frac{E_g \times \left[10^3/_T\right]}{0.198}$$

The above relation shows that the graph between $\log I_S$ and $10^3/_T$ is a straight line

Hence, the slope of straight line $= \frac{E_g}{0.198}$.

$\therefore E_g = 0.198 \times$ Slope of straight line.

The band gap is thus determined by calculating the slop of straight line.

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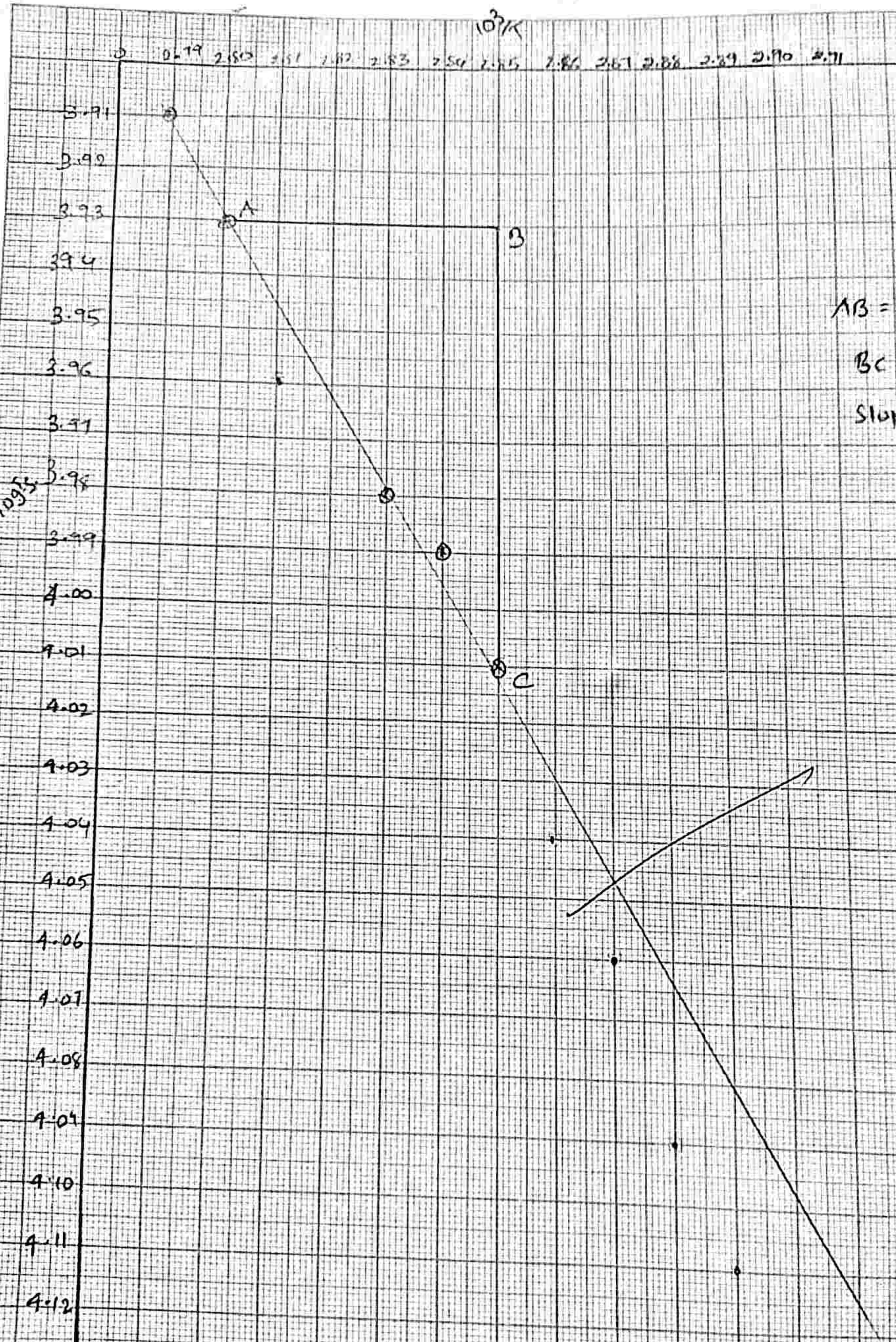
A graph between $10^3/T$ and log I_s.

SN	Temporature of water/oil bath	Temporature of water/oil bath (C + 273) = T	$10^3/T$	I_s	log I_s.
unit	°C	K	K^{-1}	$\times 10^{-6}$ A	
1.	805	358	2.79	120.9	-3.917.
2.	84	357	2.80	115.4	-3.937
3.	83	356	2.80	109.5	-3.960
4	82	355	2.81	104.1	-3.980
5	81	354	2.82	100.1	-3.999
6	80	353	2.83	95.8	-4.018
7	79	352	2.84	90.8	-4.041
8	78	351	2.85	85.9	-4.066
9	77	350	2.86	80.8	-4.092
10	76	349	2.87.	71.3.	-4.111



Scale

x-axis = 1cm = 0.01 unit

y-axis = 1cm = 0.01 unit

AB = 4.018 ~ 3.998

BC = 0.83 ~ 2.82

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

$= \frac{0.01}{.01}$

= 1.9

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Result:-

The band gap is given semiconducting material

= 0.3762 eV

Completed

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BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

School Of Science and Humanities

B.Tech Electronics and Communication Engineering

Academic Year (2018-2019) Even Sem

Model Examination - CO ATTAINMENT

U18BSPH2L2 - WaveOptics and Semiconductor Physics Lab

S.No	Reg.No	Name	Attendance	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7	Ex.8	Ex.9	Ex.10	TOTAL
1	U18EC001	AJAY K	P	4	3	4	3	6	2	3	7	2	6	4
2	U18EC002	SIDHURAMAN R	P	10	7	10	9	10	10	8	7	9	10	9
3	U18EC003	VERAMATI SATYANARAYANA	P	7	5	8	10	3	9	10	9	2	7	7
4	U18EC004	NAIDU SIVA KUMAR REDDY	P	7	5	8	10	3	9	10	9	2	7	7
5	U18EC005	KARTHICK M V	P	10	10	10	10	10	10	10	10	10	10	10
6	U18EC006	VARAMATI MOHAN KRISHNA	P	8	3	4	4	2	7	4	9	7	2	5
7	U18EC007	CHUNDRU AVINASH	P	3	2	6	3	4	3	3	2	2	2	3
8	U18EC008	GANGAVARAM DIVYASAI	P	10	10	10	10	10	10	10	10	10	10	10
9	U18EC009	KILARI MURALI	P	3	5	4	8	3	4	6	10	8	9	6
10	U18EC010	POOJARI RAKESH GOUD	P	10	10	10	10	10	10	10	10	10	10	10
11	U18EC011	PATNAM JASWANT	P	3	4	8	2	3	6	2	4	6	2	4
12	U18EC012	DHARSHAN D	P	10	10	10	10	10	10	10	10	10	10	10
13	U18EC013	KAUSALYA S	P	5	8	8	2	3	9	4	4	10	7	6
14	U18EC014	SURAJ VINAY Y	P	10	10	10	10	10	10	10	10	10	10	10
15	U18EC015	YASHVANTH P	P	8	10	9	9	10	10	8	9	7	10	9
16	U18EC016	S K NIZANTH	P	3	6	7	4	5	5	4	4	8	4	5
17	U18EC017	CHINNAMANAYANAPALLI HARI	P	9	9	9	8	10	10	10	10	5	10	9
18	U18EC018	MOWMITHA S	P	10	10	10	10	10	10	10	10	10	10	10
19	U18EC019	VEDULA GOPINADH	P	4	5	8	10	10	6	7	5	9	6	7
20	U18EC020	LENAKU RUKESWAR REDDY	P	10	10	10	10	10	10	10	10	10	10	10
21	U18EC021	KAVULURI PRAVEEN KUMAR R	P	10	8	9	7	9	4	10	9	6	8	8
22	U18EC022	BANISETTI VINAY KUMAR	P	8	9	7	6	8	2	5	9	2	4	6
23	U18EC023	HANUMANTHU ARAVINDH	P	9	10	9	10	6	8	10	10	10	8	9
24	U18EC024	NEELAM SAICHARAN	P	9	8	10	8	10	7	5	5	4	4	7
25	U18EC025	BOGGULA RAMA KRISHNA RE	P	9	2	10	10	9	9	10	2	10	9	8
26	U18EC026	VEMPATI MOULIKA	P	10	10	10	10	10	10	10	10	10	10	10
27	U18EC027	MONIKA D	P	5	2	2	3	2	6	2	3	3	2	3
28	U18EC028	VOLETI UDEEP	P	9	8	9	6	6	8	10	5	9	10	8
29	U18EC029	MD ZOHAIB	P	10	10	10	10	7	9	9	7	9	9	9
30	U18EC030	VIBIN SRI BALAJI P	P	10	10	10	10	7	9	9	7	9	9	9
31	U18EC031	GADE PAVAN KUMAR REDDY	P	10	10	10	10	7	9	9	7	9	9	9
32	U18EC032	VADDI KRISHNA MOHAN	P	6	8	6	7	10	9	10	8	8	8	8
33	U18EC033	CHINNI BHANU CHANDAR	P	9	10	10	10	8	7	6	10	10	10	9
34	U18EC034	BAKA RAMESH	P	9	10	10	10	8	7	6	10	10	10	9
35	U18EC035	BANDARU RAJESH	P	10	10	10	10	10	10	10	10	10	10	10
36	U18EC036	KOTTE SUNIL KUMAR YADAV	P	10	10	10	10	10	10	10	10	10	10	10
37	U18EC037	VEMULA KESAVA SAI NAGESH	P	10	10	10	10	10	10	10	10	10	10	10
38	U18EC038	ANNEM VINAY KUMAR REDDY	P	9	10	10	10	8	7	6	10	10	10	9
39	U18EC039	GANGULA SATEESH CHANDRA	P	10	2	3	2	4	8	5	2	10	4	5
40	U18EC040	CHITTURI YUVA KIRAN	P	10	10	10	10	10	10	10	10	10	10	10
41	U18EC041	GUTHA MAHESH	P	3	9	9	4	2	9	7	10	9	8	7
42	U18EC042	KONDETI BHAVADEESH NAIDU	P	10	9	10	10	9	6	10	8	8	10	9
43	U18EC043	DULLAM DINESH S P N NAIDU	P	10	10	6	3	9	8	4	10	10	10	8
44	U18EC044	HARIHARAN K	P	10	10	10	10	10	7	9	8	9	7	9
45	U18EC045	TUMMA YASWANTH REDDY	P	10	6	7	5	10	9	8	10	10	5	8
46	U18EC046	KAJA SAI TEJA REDDY	P	10	10	10	10	10	10	10	10	10	10	10
47	U18EC047	SIVA PRASAD REDDY VADDEB	P	10	6	7	5	10	9	8	10	10	5	8
48	U18EC048	M KARUNAKAR	P	10	6	7	5	10	9	8	10	10	5	8
49	U18EC049	NARRA SAI RAMANA	P	10	10	10	10	10	10	10	10	10	10	10
50	U18EC050	MADURI GUNA JASWANTH RE	P	2	5	2	6	2	2	4	2	2	3	3
51	U18EC051	SANIVARAPU SASI VARDHAN	P	4	2	7	2	2	3	3	2	10	5	4
52	U18EC052	GUTTIKONDA NAGARJUNA RE	P	4	2	7	2	2	3	3	2	10	5	4
53	U18EC053	KADAM MANOHAR	P	10	10	10	10	10	10	10	10	10	10	10
54	U18EC054	DURGESH P P	P	7	7	3	5	5	10	10	5	4	4	6
55	U18EC055	REPAKA USHA SRI	P	8	8	10	9	10	10	7	10	10	8	9

BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

School Of Science and Humanities

B.Tech Electronics and Communication Engineering

Academic Year (2018-2019) Even Sem

Model Examination - CO ATTAINMENT

S.No	Reg.No	Name	ttendan	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7	Ex.8	Ex.9	Ex.10	TOTAL
1	U18EC001	AJAY K	P	10	9	6	10	8	10	10	8	10	9	9
2	U18EC002	SEDHURAMAN R	P	5	10	6	7	8	9	10	9	6	10	8
3	U18EC003	VERAMATI SATYANARA	P	5	10	6	7	8	9	10	9	6	10	8
4	U18EC004	NAIDU SIVA KUMAR RI	P	5	10	6	7	8	9	10	9	6	10	8
5	U18EC005	KARTHICK M V	P	6	7	8	6	6	8	5	5	4	5	6
6	U18EC006	VARAMATI MOHAN KR	P	6	7	8	6	6	8	5	5	4	5	6
7	U18EC007	CHUNDRU AVINASH	P	10	6	9	9	10	9	8	5	8	6	8
8	U18EC008	GANGAVARAM DIVYAS	P	10	10	10	10	10	10	10	10	10	10	10
9	U18EC009	KILARI MURALI	P	9	4	4	8	3	4	3	3	9	3	5
10	U18EC010	POOJARI RAKESH GOUI	P	10	10	10	10	10	10	10	10	10	10	10
11	U18EC011	PATNAM JASWANT	P	10	10	10	10	10	10	10	10	10	10	10
12	U18EC012	DHARSHAN D	P	10	10	10	10	10	10	10	10	10	10	10
13	U18EC013	KAUSALYA S	P	10	10	7	8	10	10	8	8	9	10	9
14	U18EC014	SURAJ VINAY Y	P	10	10	10	10	10	10	10	10	10	10	10
15	U18EC015	YASHVANTH P	P	10	10	10	10	10	10	10	10	10	10	10
16	U18EC016	S K NIZANTH	P	8	6	6	5	3	4	4	3	8	3	5
17	U18EC017	CHINNAMANAYANAPAL	P	4	10	9	8	8	7	8	9	7	10	8
18	U18EC018	MOWMITHA S	P	9	10	6	10	9	9	8	9	10	10	9
19	U18EC019	VEDULA GOPINADH	P	10	10	10	10	10	10	10	10	10	10	10
20	U18EC020	LENAKU RUKESWAR RE	P	9	10	6	10	9	9	8	9	10	10	9
21	U18EC021	KAVULURI PRAVEEN KI	P	5	8	10	8	8	10	7	10	5	9	8
22	U18EC022	BANISETTI VINAY KUM	P	5	8	10	8	8	10	7	10	5	9	8
23	U18EC023	HANUMANTHU ARAVIN	P	10	10	10	10	10	10	10	10	10	10	10
24	U18EC024	NEELAM SAICHARAN	P	10	6	9	10	10	9	10	10	7	9	9
25	U18EC025	BOGGULA RAMA KRISH	P	7	6	8	7	10	8	7	4	3	10	7
26	U18EC026	VEMPATI MOULIKA	P	10	10	10	10	10	10	10	10	10	10	10
27	U18EC027	MONIKA D	P	10	8	9	10	5	6	8	10	8	6	8
28	U18EC028	VOLETI UDEEP	P	10	10	10	10	10	10	10	10	10	10	10
29	U18EC029	MD ZOHAIB	P	8	4	4	9	3	10	6	6	10	10	7
30	U18EC030	VIBIN SRI BALAJI P	P	8	4	3	4	5	4	5	9	3	5	5
31	U18EC031	GADE PAVAN KUMAR I	P	8	4	3	4	5	4	5	9	3	5	5
32	U18EC032	VADDI KRISHNA MOHA	P	6	8	10	9	9	10	9	10	10	9	9
33	U18EC033	CHINNI BHANU CHAND	P	10	10	10	10	10	10	10	10	10	10	10
34	U18EC034	BAKA RAMESH	P	10	10	10	10	10	10	10	10	10	10	10
35	U18EC035	BANDARU RAJESH	P	8	8	7	7	6	6	5	4	4	5	6
36	U18EC036	KOTTE SUNIL KUMAR	P	8	8	7	7	6	6	5	4	4	5	6
37	U18EC037	VEMULA KESAVA SAI	P	10	10	10	10	10	10	10	10	10	10	10
38	U18EC038	ANNEM VINAY KUMAR	P	10	9	9	10	9	10	6	8	10	9	9
39	U18EC039	GANGULA SATEESH CH	P	9	7	8	8	9	9	9	8	5	8	8
40	U18EC040	CHITTURI YUVA KIRAN	P	6	8	8	9	6	8	4	10	5	6	7
41	U18EC041	GUTHA MAHESH	P	10	10	10	10	10	10	10	10	10	10	10
42	U18EC042	KONDETI BHAVADEESH	P	10	10	10	10	10	10	10	10	10	10	10
43	U18EC043	DULLAM DINESH S P N	P	3	3	8	7	3	6	5	4	8	3	5
44	U18EC044	HARIHARAN K	P	10	10	9	10	9	6	10	8	8	10	9
45	U18EC045	TUMMA YASWANTH RE	P	7	5	9	10	7	7	10	3	7	5	7
46	U18EC046	KAJA SAI TEJA REDDY	P	10	10	10	10	10	10	10	10	10	10	10
47	U18EC047	SIVA PRASAD REDDY V	P	8	9	10	9	10	9	8	9	9	9	9
48	U18EC048	M KARUNAKAR	P	8	9	10	9	10	9	8	9	9	9	9
49	U18EC049	NARRA SAI RAMANA	P	10	10	10	10	10	10	10	10	10	10	10
50	U18EC050	MADURI GUNA JASWAN	P	8	9	10	9	10	9	8	9	9	9	9
51	U18EC051	SANIVARAPU SASI VAR	P	8	9	10	9	10	9	8	9	9	9	9
52	U18EC052	GUTTIKONDA NAGARJU	P	7	8	8	10	7	10	7	3	10	10	8
53	U18EC053	KADAM MANOHAR	P	7	8	8	10	7	10	7	3	10	10	8
54	U18EC054	DURGESH P P	P	8	4	6	5	3	3	4	3	8	6	5
55	U18EC055	REPAKA USHA SRI	P	9	10	8	10	9	10	5	10	10	9	9

BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

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Academic Year (2018-2019) Even Sem

Model Examination - CO ATTAINMENT

NAAC

U18BSPH2L2 - WaveOptics and Semiconductor Physics Lab

S.No	Reg.No	Name	Attendance	CO1	CO2	CO3	TOTAL	Scored			%age			CO Attained		
				Q.1	Q.2	Q.3		CO1	CO2	CO3	CO1	CO2	CO3	CO1	CO2	CO3
								30	30	40						
1	U18EC001	AJAY K	P	29	26	40	95	29	26	40	97	87	100	Y	Y	Y
2	U18EC002	SEDHURAMAN R	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
3	U18EC003	VERAMATI SATYANARA	P	29	26	40	95	29	26	40	97	87	100	Y	Y	Y
4	U18EC004	NAIDU SIVA KUMAR RE	P	23	15	27	65	23	15	27	77	50	68	Y	N	N
5	U18EC005	KARTHICK M V	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
6	U18EC006	VARAMATI MOHAN KRIS	P	24	25	26	75	24	25	26	80	83	65	Y	Y	N
7	U18EC007	CHUNDRU AVINASH	P	24	20	36	80	24	20	36	80	67	90	Y	N	Y
8	U18EC008	GANGAVARAM DIVYASA	P	24	20	36	80	24	20	36	80	67	90	Y	N	Y
9	U18EC009	KILARI MURALI	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
10	U18EC010	POOJARI RAKESH GOUD	P	24	20	36	80	24	20	36	80	67	90	Y	N	Y
11	U18EC011	PATNAM JASWANT	P	24	20	36	80	24	20	36	80	67	90	Y	N	Y
12	U18EC012	DHARSHAN D	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
13	U18EC013	KAUSALYA S	P	30	11	29	70	30	11	29	100	37	73	Y	N	N
14	U18EC014	SURAJ VINAY Y	P	23	20	32	75	23	20	32	77	67	80	Y	N	Y
15	U18EC015	YASHVANTH P	P	4	28	28	60	4	28	28	13	93	70	N	Y	N
16	U18EC016	S K NIZANTH	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
17	U18EC017	CHINNAMANAYANAPALL	P	25	0	25	50	25	0	25	83	0	63	Y	N	N
18	U18EC018	MOWMITHA S	P	29	22	39	90	29	22	39	97	73	98	Y	Y	Y
19	U18EC019	VEDULA GOPINADH	P	20	27	28	75	20	27	28	67	90	70	N	Y	N
20	U18EC020	LENAKU RUKESWAR RE	P	11	9	25	45	11	9	25	37	30	63	N	N	N
21	U18EC021	KAVULURI PRAVEEN KU	P	17	25	38	80	17	25	38	57	83	95	N	Y	Y
22	U18EC022	BANISETTI VINAY KUMA	P	30	27	28	85	30	27	28	100	90	70	Y	Y	N
23	U18EC023	HANUMANTHU ARAVIND	P	4	16	20	40	4	16	20	13	53	50	N	N	N
24	U18EC024	NEELAM SAICHARAN	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
25	U18EC025	BOGGULA RAMA KRISHN	P	28	30	22	80	28	30	22	93	100	55	Y	Y	N
26	U18EC026	VEMPATI MOULIKA	P	29	8	23	60	29	8	23	97	27	58	Y	N	N
27	U18EC027	MONIKA D	P	27	29	19	75	27	29	19	90	97	48	Y	Y	N
28	U18EC028	VOLETI UDEEP	P	14	14	32	60	14	14	32	47	47	80	N	N	Y
29	U18EC029	MD ZOHAIB	P	26	26	33	85	26	26	33	87	87	83	Y	Y	Y
30	U18EC030	VIBIN SRI BALAJI P	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
31	U18EC031	GADE PAVAN KUMAR R	P	1	29	40	70	1	29	40	3	97	100	N	Y	Y
32	U18EC032	VADDI KRISHNA MOHAN	P	28	30	32	90	28	30	32	93	100	80	Y	Y	Y
33	U18EC033	CHINNI BHANU CHANDA	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
34	U18EC034	BAKA RAMESH	P	16	26	38	80	16	26	38	53	87	95	N	Y	Y
35	U18EC035	BANDARU RAJESH	P	4	30	16	50	4	30	16	13	100	40	N	Y	N
36	U18EC036	KOTTE SUNIL KUMAR Y	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
37	U18EC037	VEMULA KESAVA SAI N	P	25	29	36	90	25	29	36	83	97	90	Y	Y	Y
38	U18EC038	ANNEM VINAY KUMAR	P	25	29	36	90	25	29	36	83	97	90	Y	Y	Y
39	U18EC039	GANGULA SATEESH CHA	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
40	U18EC040	CHITTURI YUVA KIRAN	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
41	U18EC041	GUTHA MAHESH	P	25	29	36	90	25	29	36	83	97	90	Y	Y	Y
42	U18EC042	KONDETI BHAVADEESH	P	25	27	33	85	25	27	33	83	90	83	Y	Y	Y
43	U18EC043	DULLAM DINESH S P N N	P	22	29	39	90	22	29	39	73	97	98	N	Y	Y
44	U18EC044	HARIHARAN K	P	25	23	27	75	25	23	27	83	77	68	Y	Y	N
45	U18EC045	TUMMA YASWANTH REI	P	25	23	27	75	25	23	27	83	77	68	Y	Y	N
46	U18EC046	KAJA SAI TEJA REDDY	P	24	4	22	50	24	4	22	80	13	55	Y	N	N
47	U18EC047	SIVA PRASAD REDDY V	P	30	19	36	85	30	19	36	100	63	90	Y	N	Y
48	U18EC048	M KARUNAKAR	P	30	30	40	100	30	30	40	100	100	100	Y	Y	Y
49	U18EC049	NARRA SAI RAMANA	P	22	12	36	70	22	12	36	73	40	90	N	N	Y
50	U18EC050	MADURI GUNA JASWAN	P	30	24	36	90	30	24	36	100	80	90	Y	Y	Y
51	U18EC051	SANIVARAPU SASI VARD	P	30	29	26	85	30	29	26	100	97	65	Y	Y	N
52	U18EC052	GUTTIKONDA NAGARJUN	P	26	29	40	95	26	29	40	87	97	100	Y	Y	Y
53	U18EC053	KADAM MANOHAR	P	26	29	40	95	26	29	40	87	97	100	Y	Y	Y
54	U18EC054	DURGESH P P	P	26	14	15	55	26	14	15	87	47	38	Y	N	N
55	U18EC055	REPAKA USHA SRI	P	27	28	35	90	27	28	35	90	93	88	Y	Y	Y

BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

School Of Science and Humanities

Academic Year (2018-2019) Ev

Model Examination - CO ATTAINMENT

U18BSPH2L2 - WaveOptics and Semiconductor Physics Lal

S.No	Reg.No	Name	Attendanc				%age			CO Attained			
				CO1	CO2	CO3	CO1	CO2	CO3	CO1	CO2	CO3	
				Q.1	Q.2	Q.3	75	70	75				
1	U18EC001	AJAY K	P	30	9	40	100	30	100	Y	N	Y	72
2	U18EC002	SEDHURAMAN R	P	29	28	40	97	93	100	Y	Y	Y	77
3	U18EC003	VERAMATI SATYA	P	25	22	35	83	73	88	Y	Y	Y	57
4	U18EC004	NAIDU SIVA KUM	P	23	25	30	77	83	75	Y	Y	Y	77
5	U18EC005	KARTHICK M V	P	27	27	30	90	90	75	Y	Y	Y	77
6	U18EC006	VARAMATI MOHA	P	24	23	34	80	77	85	Y	Y	Y	74
7	U18EC007	CHUNDRU AVINAS	P	25	22	23	83	73	58	Y	Y	N	79
8	U18EC008	GANGAVARAM DI	P	29	14	26	97	47	65	Y	N	N	87
9	U18EC009	KILARI MURALI	P	30	14	40	100	47	100	Y	N	Y	52
10	U18EC010	POOJARI RAKESH	P	25	12	35	83	40	88	Y	N	Y	57
11	U18EC011	PATNAM JASWAN	P	26	28	34	87	93	85	Y	Y	Y	80
12	U18EC012	DHARSHAN D	P	29	29	39	97	97	98	Y	Y	Y	94
13	U18EC013	KAUSALYA S	P	28	30	14	93	100	35	Y	Y	N	97
14	U18EC014	SURAJ VINAY Y	P	24	21	32	80	70	80	Y	Y	Y	49
15	U18EC015	YASHVANTH P	P	11	17	39	37	57	98	N	N	Y	80
16	U18EC016	S K NIZANTH	P	26	30	36	87	100	90	Y	Y	Y	52
17	U18EC017	CHINNAMANAYAN	P	18	21	28	60	70	70	N	Y	N	54
18	U18EC018	MOWMITHA S	P	24	28	37	80	93	93	Y	Y	Y	84
19	U18EC019	VEDULA GOPINAD	P	25	25	25	83	83	63	Y	Y	N	50
20	U18EC020	LENAKU RUKESW	P	11	22	29	37	73	73	N	Y	N	55
21	U18EC021	KAVULURI PRAVE	P	15	25	40	50	83	100	N	Y	Y	82
22	U18EC022	BANISETTI VINAY	P	26	21	37	87	70	93	Y	Y	Y	79
23	U18EC023	HANUMANTHU AF	P	25	19	18	83	63	45	Y	N	N	60
24	U18EC024	NEELAM SAICHAR	P	30	29	40	100	97	100	Y	Y	Y	79
25	U18EC025	BOGGULA RAMA	P	5	23	36	17	77	90	N	Y	Y	70
26	U18EC026	VEMPATI MOULIK	P	25	17	40	83	57	100	Y	N	Y	74
27	U18EC027	MONIKA D	P	24	11	32	80	37	80	Y	N	Y	79
28	U18EC028	VOLETI UDEEP	P	20	20	37	67	67	93	N	N	Y	50
29	U18EC029	MD ZOHAIB	P	27	22	33	90	73	83	Y	Y	Y	74
30	U18EC030	VIBIN SRI BALAJI	P	29	30	40	97	100	100	Y	Y	Y	59
31	U18EC031	GADE PAVAN KU	P	20	30	15	67	100	38	N	Y	N	79
32	U18EC032	VADDI KRISHNA	P	26	29	32	87	97	80	Y	Y	Y	75
33	U18EC033	CHINNI BHANU C	P	30	20	35	100	67	88	Y	N	Y	57
34	U18EC034	BAKA RAMESH	P	17	24	36	57	80	90	N	Y	Y	92
35	U18EC035	BANDARU RAJESH	P	26	0	36	87	0	90	Y	N	Y	57
36	U18EC036	KOTTE SUNIL KU	P	30	30	39	100	100	98	Y	Y	Y	74
37	U18EC037	VEMULA KESAVA	P	10	28	39	33	93	98	N	Y	Y	65
38	U18EC038	ANNEM VINAY KU	P	29	28	38	97	93	95	Y	Y	Y	69
39	U18EC039	GANGULA SATEES	P	30	20	40	100	67	100	Y	N	Y	79
40	U18EC040	CHITTURI YUVA	P	30	30	40	100	100	100	Y	Y	Y	57
41	U18EC041	GUTHA MAHESH	P	25	24	40	83	80	100	Y	Y	Y	74
42	U18EC042	KONDETI BHAVAI	P	18	21	35	60	70	88	N	Y	Y	59
43	U18EC043	DULLAM DINESH	P	24	29	32	80	97	80	Y	Y	Y	77
44	U18EC044	HARIHARAN K	P	22	29	28	73	97	70	N	Y	N	80
45	U18EC045	TUMMA YASWAN	P	22	29	28	73	97	70	N	Y	N	77
46	U18EC046	KAJA SAI TEJA R	P	16	29	22	53	97	55	N	Y	N	80
47	U18EC047	SIVA PRASAD REI	P	25	23	31	83	77	78	Y	Y	Y	77
48	U18EC048	M KARUNAKAR	P	30	20	39	100	67	98	Y	N	Y	62

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Indirect - CO Attainment

S.No	Reg.No	Name	CO1	CO2	CO3	CO1	CO2	CO3
1	U18EC001	AJAY K	5	3	5	Y	Y	Y
2	U18EC002	SEDHURAMAN R	5	5	4	Y	Y	Y
3	U18EC003	VERAMATI SATYANARAYANA	5	3	5	Y	Y	Y
4	U18EC004	NAIDU SIVA KUMAR REDDY	5	5	5	Y	Y	Y
5	U18EC005	KARTHICK M V	5	3	4	Y	Y	Y
6	U18EC006	VARAMATI MOHAN KRISHNA	5	3	3	Y	Y	Y
7	U18EC007	CHUNDRU AVINASH	5	4	4	Y	Y	Y
8	U18EC008	GANGAVARAM DIVYASAI	4	4	1	Y	Y	N
9	U18EC009	KILARI MURALI	4	5	5	Y	Y	Y
10	U18EC010	POOJARI RAKESH GOUD	3	4	3	Y	Y	Y
11	U18EC011	PATNAM JASWANT	4	3	3	Y	Y	Y
12	U18EC012	DHARSHAN D	4	4	4	Y	Y	Y
13	U18EC013	KAUSALYA S	5	4	5	Y	Y	Y
14	U18EC014	SURAJ VINAY Y	4	1	3	Y	N	Y
15	U18EC015	YASHVANTH P	4	3	5	Y	Y	Y
16	U18EC016	S K NIZANTH	4	5	5	Y	Y	Y
17	U18EC017	CHINNAMANAYANAPALLI HARISH KUM	4	5	5	Y	Y	Y
18	U18EC018	MOWMITHA S	4	5	2	Y	Y	N
19	U18EC019	VEDULA GOPINADH	5	4	2	Y	Y	N
20	U18EC020	LENAKU RUKESWAR REDDY	5	4	3	Y	Y	Y
21	U18EC021	KAVULURI PRAVEEN KUMAR REDDY	4	5	3	Y	Y	Y
22	U18EC022	BANISETTI VINAY KUMAR	4	4	2	Y	Y	N
23	U18EC023	HANUMANTHU ARAVINDH	3	4	4	Y	Y	Y
24	U18EC024	NEELAM SAICHARAN	5	3	2	Y	Y	N
25	U18EC025	BOGGULA RAMA KRISHNA REDDY	5	4	4	Y	Y	Y
26	U18EC026	VEMPATI MOULIKA	5	5	3	Y	Y	Y
27	U18EC027	MONIKA D	4	5	3	Y	Y	Y
28	U18EC028	VOLETI UDEEP	5	5	3	Y	Y	Y
29	U18EC029	MD ZOHAIB	4	5	3	Y	Y	Y
30	U18EC030	VIBIN SRI BALAJI P	5	5	5	Y	Y	Y
31	U18EC031	GADE PAVAN KUMAR REDDY	5	5	5	Y	Y	Y
32	U18EC032	VADDI KRISHNA MOHAN	4	4	5	Y	Y	Y
33	U18EC033	CHINNI BHANU CHANDAR	5	2	5	Y	N	Y
34	U18EC034	BAKA RAMESH	5	5	2	Y	Y	N
35	U18EC035	BANDARU RAJESH	5	4	2	Y	Y	N
36	U18EC036	KOTTE SUNIL KUMAR YADAV	5	5	3	Y	Y	Y
37	U18EC037	VEMULA KESAVA SAI NAGESH	5	5	4	Y	Y	Y
38	U18EC038	ANNEM VINAY KUMAR REDDY	5	5	4	Y	Y	Y
39	U18EC039	GANGULA SATEESH CHANDRA	5	4	5	Y	Y	Y
40	U18EC040	CHITTURI YUVA KIRAN	5	3	5	Y	Y	Y
41	U18EC041	GUTHA MAHESH	4	3	3	Y	Y	Y
42	U18EC042	KONDETI BHAVADEESH NAIDU	5	2	4	Y	N	Y
43	U18EC043	DULLAM DINESH S P N NAIDU	2	5	4	N	Y	Y
44	U18EC044	HARIHARAN K	5	4	3	Y	Y	Y
45	U18EC045	TUMMA YASWANTH REDDY	5	5	3	Y	Y	Y
46	U18EC046	KAJA SAI TEJA REDDY	5	4	5	Y	Y	Y
47	U18EC047	SIVA PRASAD REDDY VADDEBOINA	5	5	3	Y	Y	Y
48	U18EC048	M KARUNAKAR	5	2	2	Y	N	N
49	U18EC049	NARRA SAI RAMANA	2	4	3	N	Y	Y
50	U18EC050	MADURI GUNA JASWANTH RESSY	5	5	2	Y	Y	N
51	U18EC051	SANIVARAPU SASI VARDHAN	3	3	4	Y	Y	Y
52	U18EC052	GUTTIKONDA NAGARJUNA REDDY	5	3	5	Y	Y	Y
53	U18EC053	KADAM MANOHAR	5	2	5	Y	N	Y
54	U18EC054	DURGESH P P	4	2	3	Y	N	Y
55	U18EC055	REPAKA USHA SRI	5	4	5	Y	Y	Y

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CO Attainment Gap Analysis

	TARGET %AG	TAINED %A(	GAP
CO1	75	76	-1
CO2	70	74	-4
CO3	75	76	-1

COURSE IN-CHARGE **HOD - Physics**

Dr. R. VELAVAN, M.Sc.,M.Phil.,Ph.D.,
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CO Attainment Gap Analysis - Action Taken Report

CO	Target Percenta	CO Attainment Gap Percentage	Action Proposed to Bridge the Gap	Modification Of Target When Achieved
CO1	75	-1	Target Achieved	Target increased to 78
CO2	70	-4	Target Achieved	Target increased to 75
CO3	75	-1	Target Achieved	Target increased to 77

COURSE IN-CHARGE

R. V. Lavan

HOD - Physics

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