NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE

(NAACAccredited)

(Approved by AICTE , Affiliated to APJ Abdul Kalam Technological University, Kerala)

Pampady, Thiruvilwamala(PO), Thrissur(DT), Kerala 680 588

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

LAB MANUAL

PH110 ENGINEERING PHYSICS LAB

VISION OF THE INSTITUTION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION OF THE INSTITUTION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT THE DEPARTMENT

- Established in: 2002
- Course offered : B.Tech in Computer Science and Engineering

  M.Tech in Computer Science and Engineering

M.Tech in Cyber Security

- Approved by AICTENew Delhi and Accredited by NAAC
- Certified by ISO 9001-2015
- Affiliated to A P J Abdul Kalam Technological University, Kerala.

DEPARTMENT VISSION

Producing Highly Competent, Innovative and Ethical Computer Science and Engineering Professionals to facilitate continuous technological advancement.

DEPARTMENT MISSION

1. To Impart Quality Education by creative Teaching Learning Process
2. To Promote cutting-edge Research and Development Process to solve real world problems with emerging technologies.
3. To Inculcate Entrepreneurship Skills among Students.
4. To cultivate Moral and Ethical Values in their Profession.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Graduates will be able to Work and Contribute in the domains of Computer Science and Engineering through lifelong learning.

PEO2: Graduates will be able to Analyse, design and development of novel Software Packages, Web Services, System Tools and Components as per needs and specifications.

PEO3: Graduates will be able to demonstrate their ability to adapt to a rapidly changing environment by learning and applying new technologies.

PEO4: Graduates will be able to adopt ethical attitudes, exhibit effective communication skills, Team work and leadership qualities.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design

system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO1: Ability to Formulate and Simulate Innovative Ideas to provide software solutions for Real-time Problems and to investigate for its future scope.

PSO2: Ability to learn and apply various methodologies for facilitating development of high quality System Software Tools and Efficient Web Design Models with a focus on performance optimization.

PSO3: Ability to inculcate the Knowledge for developing Codes and integrating hardware/software products in the domains of Big Data Analytics, Web Applications and Mobile Apps to create innovative career path and for the socially relevant issues.

COURSE OUTCOME

SUBJECT CODE: C102	
COURSE OUTCOMES	
C102.1	Compute the quantitative aspects of waves and oscillations in engineering systems.
C102.2	Understand the importance of properties of light
C102.3	Classify and describe the properties of semiconductor materials and its application
C102.4	Acquire knowledge of basic principal of quantum mechanics and statistical mechanics
C102.5	Realize the importance of application of Acoustics and Ultrasonic
C102.6	Develop a comprehension of the current basis of board knowledge in photonics

CO VS PO'S AND PSO'S MAPPING

CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C102.1	3	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
C102.2	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
C102.3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
C102.4	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
C102.5	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
C102.6	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
C102	**3.00**	**3.00**	**3.00**	**3.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.00**

Note: H-Highly correlated=3, M-Medium correlated=2, L-Less correlated=1

CO'S	PSO1	PSO2	PSO3
C102.1	2		
C102.2	2		
C102.3	2	2	2
C102.4	2	2	
C102.5	2		
C102.6	2	2	2
C102	2	2	2

PREPARATION FOR THE LABORATORY SESSION
GENERAL INSTRUCTIONS TO STUDENTS

1. Read carefully and understand the description of the experiment in the lab manual. You may go to the lab at an earlier date to look at the experimental facility and understand it better. Consult the appropriate references to be completely familiar with the concepts and hardware.

2. Make sure that your observation for previous week experiment is evaluated by the faculty member and you have transferred all the contents to your record before entering to the lab/workshop.

3. At the beginning of the class, if the faculty or the instructor finds that a student is not adequately prepared, they will be marked as absent and not be allowed to perform the experiment.

4. Bring necessary material needed (writing materials, graphs, calculators, etc.) to perform the required preliminary analysis. It is a good idea to do sample calculations and as much of the analysis as possible during the session. Faculty help will be available. Errors in the procedure may thus be easily detected and rectified.

5. Please actively participate in class and don’t hesitate to ask questions. Please utilize the teaching assistants fully. To encourage you to be prepared and to read the lab manual before coming to the laboratory, unannounced questions may be asked at any time during the lab.

6. Carelessness in personal conduct or in handling equipment may result in serious injury to the individual or the equipment. Do not run near moving machinery/equipment. Always be on the alert for strange sounds. Guard against entangling clothes in moving parts of machinery.

7. Students must follow the proper dress code inside the laboratory. To protect clothing from dirt, wear a lab coat. Long hair should be tied back. Shoes covering the whole foot will have to be worn.

8. In performing the experiments, please proceed carefully to minimize any water spills, especially on the electric circuits and wire.

9. Maintain silence, order and discipline inside the lab. Don’t use cell phones inside the laboratory.

10. Any injury no matter how small must be reported to the instructor immediately.

11. Check with faculty members one week before the experiment to make sure that you have the handout for that experiment and all the apparatus.

AFTER THE LABORATORY SESSION

1. Clean up your work area.

2. Check with the technician before you leave.

3. Make sure you understand what kind of report is to be prepared and due submission of record is next lab class.

4. Do sample calculations and some preliminary work to verify that the experiment was successful

MAKE-UPS AND LATE WORK

Students must participate in all laboratory exercises as scheduled. They must obtain permission from the faculty member for absence, which would be granted only under justifiable circumstances. In such an event, a student must make arrangements for a make-up laboratory, which will be scheduled when the time is available after completing one cycle. Late submission will be awarded less mark for record and internals and zero in worst cases.

LABORATORY POLICIES

1. Food, beverages & mobile phones are not allowed in the laboratory at any time.

2. Do not sit or place anything on instrument benches.

3. Organizing laboratory experiments requires the help of laboratory technicians and staff. Be punctual.

SYLLABUS

Course No.	Course Name	L-T-P-Credits	Year of Introduction
PH110	**ENGINEERING PHYSICS LAB**	**0-0-2-1**	**2015**

Course Objectives

This course is designed (i) to impart practical knowledge about some of the phenomena they have studied in the Engineering Physics course and (ii) to develop the experimental skills of the students.

List of Exercises / Experiments (Minimum of 8 mandatory)

Basics

1. Study of application of Cathode Ray Oscilloscope (CRO) for Frequency and Amplitude measurements. Lissajeous figures (useful for different types of polarized light.)
2. Temperature measurement – Thermocouple
3. Measurement of strain using strain gauge and Wheatstones bridge.

Waves, Oscillations and Ultrasonics

4. Wave length and velocity measurement of ultrasonic waves in a liquid using ultrasonic diffractometer.
5. The LCR Circuit – Forced and damped harmonic oscillations.
6. Meldes string apparatus. Measurement of frequency in the transverse and longitudinal mode.

Interference

7. Wave length measurement of a monochromatic source of light using Newton’s Rings method.

8. Determination of refractive index of a liquid using Newton’s Rings apparatus.

9. Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.

Diffraction

10. To determine the slit or pinhole width.

11. To measure wavelength using a millimeter scale as a grating.

12. Determination the wavelength of He-Ne laser or any standard laser using diffraction grating.

13. To determine the wavelength of monochromatic light using grating.

14. Determination of dispersive power and resolving power of a plane transmission grating.

Polarisation

15. Kerr Effect - To demonstrate the Kerr effect in nitrobenzene solution and to measure the light intensity as a function of voltage across the Kerr cell using photo detector.

16. To measure the light intensity of plane polarised light as a function of the analyzer position.

17. Laurent’s Half Shade Polarimeter -To observe the rotation of the plane of polarization of monochromatic light by sugar solution and hence to determine the concentration of solution of optically active substance.

Laser & Photonics

18. To determine the speed of light in air using laser.

19. Calculate the numerical aperture and study the losses that occur in optical fiber cable.

20. Determination of the particle size of lycopodium powder.

21. I-V characteristics of solar cell

22. To measure Planck’s constant using photo electric cell.

23. Measurement of wavelength of laser using grating.

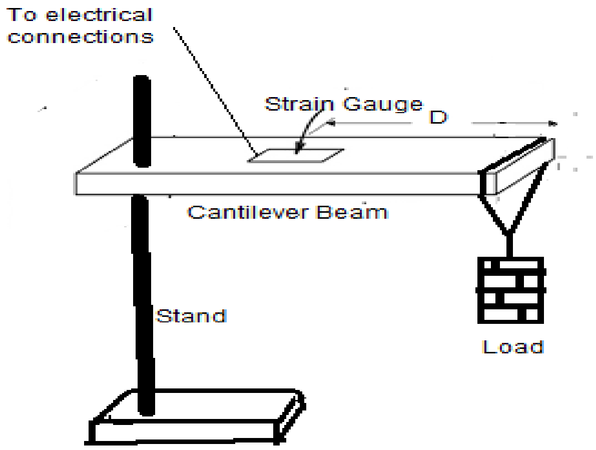
Reference Books:

- Avadhanulu, M. N., Dani, A. A. and Pokley, P. M., Experiments in Engineering Physics, S. Chand & Co.
- Gupta, S. K., Engineering Physics Practicals, Krishna Prakashan Pvt. Ltd.
- Koser, A. A., Practical Engineering Physics, Nakoda Publishers and Printers India Ltd
- Rao, B. S. and Krishna, K. V., Engineering Physics Practicals, Laxmi Publications
- Sasikumar, P. R. Practical Physics, PHI.

Website:

- http://www.indosawedu.com

INDEX



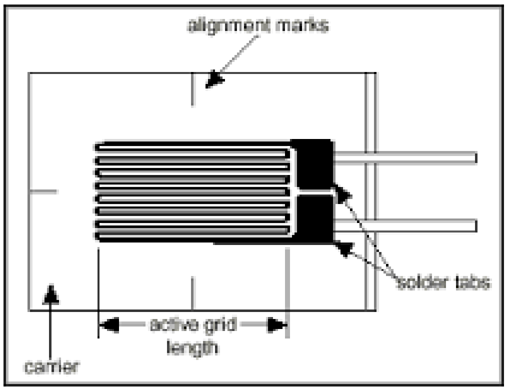


Fig-1-Experimental set up

Fig-2-Stain gauge

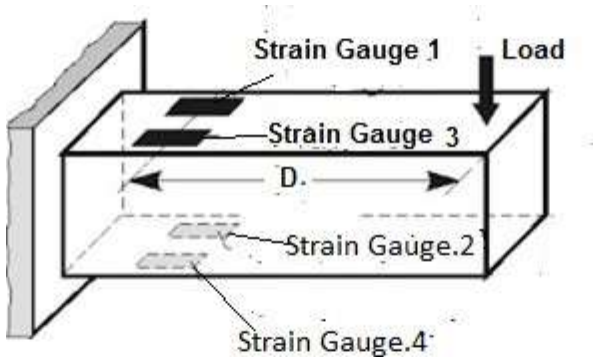


Fig-3- Strain gauge arrangement

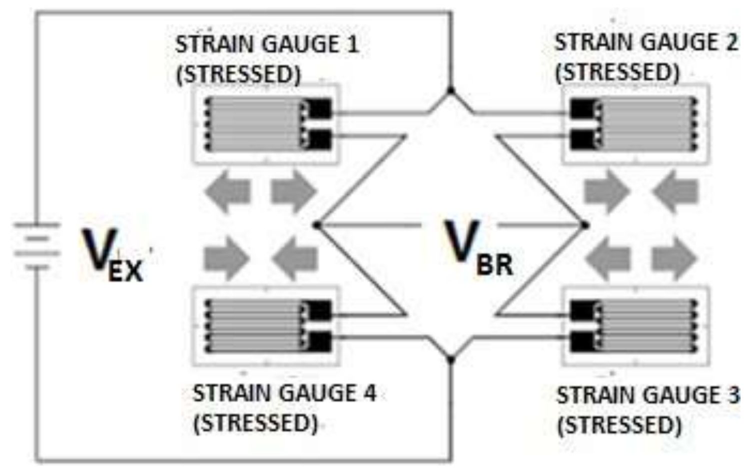


Fig-4-Full Bridge Strain gauge ciruit

1. STRAIN GAUGE

Objective:

To measure the strain in a loaded cantilever (Load ∞ Strain).

Principle:

Strain gauges are thin wires that can be glued to a metal structure (*cantilever*). When the structure flexes(bends) under a load, the resistance of the strain gauge changes and this can be used to measure the strain in the structure.

The change in resistance(ΔR) in a strain gauge of resistance R is very nearly proportional to the strain(ε).

$\{\frac{\Delta R}{R}\} \propto \varepsilon$,ie., $\{\frac{\Delta R}{R}\} = F\varepsilon$, where F is a constant called Gauge Factor.

Strain gauges are used in a bridge type with a voltage excitation source (V_{EX}). Wheatstone's bridge consists of 4 arms of resistance with an excitation voltage. In the balanced condition,the bridge voltage(o/p voltage) $V_{BR} = 0$. Any change in resistance in any arm of the bridge results in a non-zero bridge voltage.

If one of the arms of the bridge is replaced by a strain gauge it is called a Quarter bridgeand if all the four arms are replaced by strain gauges it is called a Full bridge Strain Gauge network(fig.4). Full bridge is more sensitive.

For a full bridge, we have $V_{BR} = V_{EX}.F\varepsilon$

The strain,ε, can be calculated using the formula, $\varepsilon = \{\frac{V_{BR}}{F.V_{EX}}\}$

Materials & Methods:

Cantilever beam with full bridge strain gauge, strain voltage indicator, external voltage source,1 kg set of 50g masses (individually marked with accurate masses).

1. Experimental set up is as shown in figure 1.
2. Strain voltage indicator (V_{BR}) is connected.
3. With zero load, V_{BR} is noted.

Observations External
Voltage V_{EX} =Gauge
Factor, F =

Trial No.	Load in grams	o/p voltage, V_{BR} in mV			Strain, $\varepsilon = \{\frac{V_{BR}}{F.V_{EX}}\}$
		1	2	mean	
1					
2					

4. Load is increased in steps of 50 g(upto *within the limits of elasticity*) and V_{BR} isnoted in each case.
5. Knowing the gauge factor,F and supply voltage,V_{EX} , the strain,ε is calculated.
6. A graph is plotted with V_{BR} against load.

Result:

Strain is found proportional to (i)the o/p voltage and (ii) load.

Conclusion:

Load ∞o/p voltage& Strain ∞ o/p voltage

Hence Load ∞ Strain.

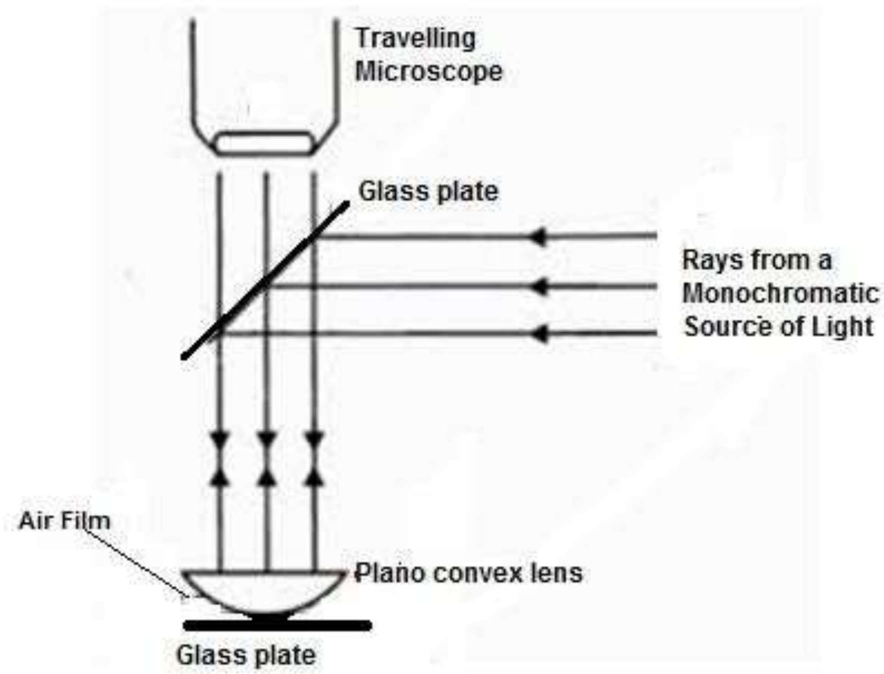


Fig.1 – Newton's rings set up

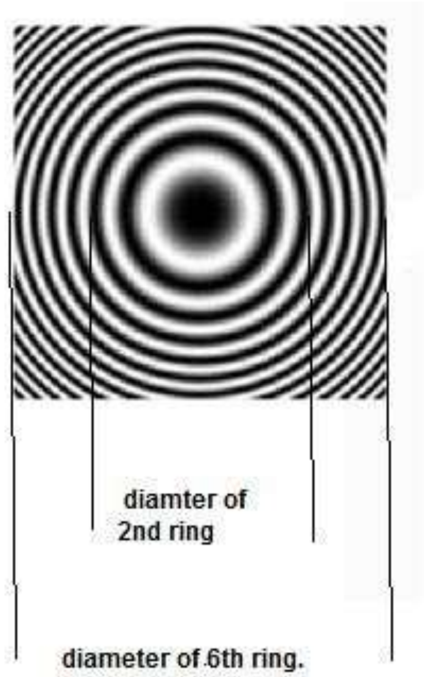


Fig.2 - Newton's rings

2. NEWTON'S RINGS – I

Objective:

To determine the wavelength of Sodium light under the reflected system.

Principle:

$D_n^2 = 4nR\lambda$, where D_n is the diameter of nth dark ring.

$D_{n+k}^2 = 4(n+k)R\lambda$, where D_{n+k} is the diameter of (n+k)th dark ring.

Then wavelength, $\lambda = \left\{ \dfrac{(D_{n+k}^2 - D_n^2)}{4kR} \right\}$

Materials & Methods:

Newton's rings apparatus set up, sodium vapour lamp, travelling microscope, planoconvex lens or biconvex lens of large focal length etc.

1. Experimental set up is made as shown in the figure.
2. Eye piece of the microscope is adjusted by moving up or down until the Newton's rings are seen clearly.
3. Cross wire in the eye piece is adjusted and brought in line with the centre of central dark ring.
4. The microscope is then moved horizontally towards left side of the central dark ring and the cross wire is made to coincide tangentially on, say, the 14th dark ring .
5. Microscope reading is now noted.
6. Microscope is then moved to 12th, 10th etc. upto 2nd dark ringand readingsare noted in each case.
7. The microscope is now moved to the right side of the central dark ring andthe readings are noted for 2nd, 4thetc upto 14th dark ring.
8. The difference between the readings on the left and the right of each darkring gives the diameter (D) of that ring.
9. D and D^2 are calculated.
10. The difference in D^2 of 4 rings apart is calculated using $(D_{n+k}^2 - D_n^2)$ with k=4 and the mean $(D_{n+k}^2 - D_n^2)$ is found out.
11. Knowing the radius of curvature, R of the planoconvex lens, the wavelengthof the sodium light is calculated using the formula given above.

Observations

One Main Scale Reading (MSR) =

No: of Vernier Scale Division(VSD) =

Least Count(LC)= 1MSR/No.of
VSD =Total = MSR + (VSDxLC)

No. of Dark Rings	Microscope Readings - cm						Diameter D=A-B cm	D^2 cm^2	$D^2_{n+k} - D^2_n$ cm^2
	Left			Right					
	MSR	VSD	TOTAL= A	MSR	VSD	TOTAL= B			
14									
12									
10									
8									
6									
4									
2									

Mean $D^2_{n+k} - D^2_n$ =

Result:

The wavelength of Sodium light =

Conclusion:

The wavelength of the monochromatic source of light (sodium light) iscalculated and found almost in good agreement with the theoretical value.

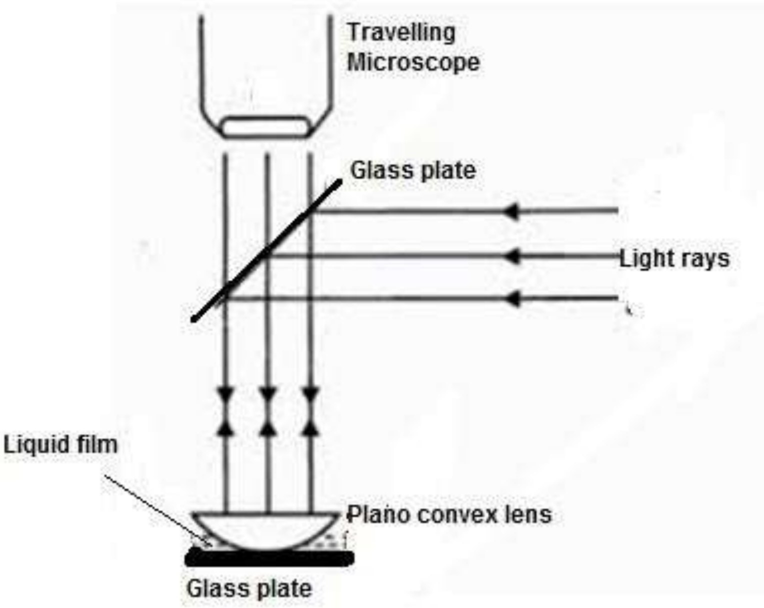


Fig.1 – Newton's rings set up for the determination of Refractive index of a liquid

3. NEWTON'S RINGS –II

Objective:

To determine the Refractive index of a liquid

Principle:

With air film between the plane glass plate and plano convex lens we have,

$D_n^2 = 4nR\lambda$, where D_n is the diameter of nth dark ring.

$D_{n+k}^2 = 4(n+k)R\lambda$, where D_{n+k} is the diameter of (n+k)th dark ring.

Then wavelength, $\lambda = \left\{\frac{(D_{n+k}^2 - D_n^2)}{4kR}\right\}$

Replacing air with a liquid film, we have,

wavelength , $\lambda = \mu\left\{\frac{(d_{n+k}^2 - d_n^2)}{4kR}\right\}$, where μ is the refractive index of the liquid.

Then $\mu = \left\{\frac{(D_{n+k}^2 - D_n^2)}{(d_{n+k}^2 - d_n^2)}\right\}$

Materials & Methods:

Newton's rings apparatus set up, sodium vapour lamp, travelling microscope, plano convex lens or biconvex lens of large focal length, given liquid etc.

1. With air film the experimental set up is made as shown in the figure.
2. Eye piece of the microscope is adjusted by moving up or down until the Newton's rings are seen clearly.
3. Cross wire in the eye piece is adjusted and brought in line with the centre ofcentral dark ring.
4. The microscope is then moved horizontally towards left side of the central dark ring and the cross wire is made to coincide tangentially on, say, the 14th dark ring .
5. Microscope reading is now noted.
6. Microscope is then moved to 12th, 10th etc. upto 2nd dark ring on the left side and readings are noted in each case.

Observations.

One Main Scale Reading (MSR) =
No: of Vernier Scale Division(VSD) =

Least Count(LC)= 1MSR/No. of VSD =Total = MSR + (VSDxLC)

1. With Air film

No. of Dark Rings	Microscope Readings - cm						Diameter D=A-B cm	D^2 cm^2	$D^2_{n+k} - D^2_n$ cm^2 (*with k=4*)
	Left			Right					
	MSR	VSD	TOTAL= A	MSR	VSD	TOTAL= B			
14									
12									
10									
8									
6									
4									
2									

Mean $D^2_{n+k} - D^2_n$ =

2. With Liquid film

No. of Dark Rings	Microscope Readings - cm						Diameter d=A-B cm	d^2 cm^2	$d^2_{n+k} - d^2_n$ cm^2 (*with k=4*)
	Left			Right					
	MSR	VSD	TOTAL= A	MSR	VSD	TOTAL= B			
14									
12									
10									
8									
6									
4									
2									

Mean $d^2 - d^2$ =

n+k n

Hence Refractive index of the given liquid, $\mu = (D^2_{n+k} - D^2_n) / (d^2_{n+k} - d^2_n) =$

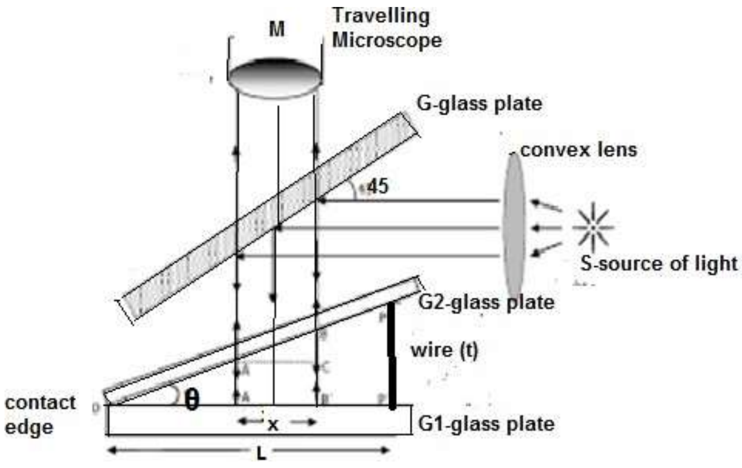
7. The microscope is then moved to the right side of the central dark ring andthe readings are noted for 2nd, 4thetc up to 14th dark ring.
8. The difference between the readings on the left and the right of each darkring gives the diameter (D) of that ring.
9. Thus D and D^2 are calculated.
10. The difference in D^2 of 4 rings apart is calculated using $(D^2_{n+k} - D^2_n)$ with k=4 and the mean $(D^2_{n+k} - D^2_n)$ is found out.
11. Now air is replaced by the given liquid of refractive indexμ between theglass plate and the planoconvex lens.
12. The same procedure, adopted for air film, is repeated and the mean $(d^2_{n+k} - d^2_n)$ is calculated.
13. Refractive indexμ of the given liquid is calculated using the formula givenabove.

Result:

The Refractive index of the given liquid =

Conclusion:

When the air film between the plane glass plate and the planoconvex lens orbiconvex lens is replaced by a liquid the rings came closer.



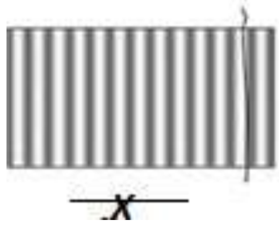


Fig.1 – Air wedge set up *Fig.2 Bright & Dark Fringes*

Observations

One Main Scale Reading (MSR) =

No. of Vernier Scale Division (VSD)

=LeastCount(LC)=1MSR/No.of VSD=

Total = MSR + (VSD x LC)

No. of Dark Rings	Microscope Readings - cm			Width of 5 fringes=x (cm)	Fringe width,β=x/5 (cm)
	Left				
	MSR	VSD	TOTAL= A		
n					
n+5					
n+10					
n+15					
n+20					
n+25					

Mean fringe width, β =

Wavelength of sodium light,λ =

length of the wedge,L =

Diameter of the thin wire, $d = \frac{Lh}{2\beta} =$

4.AIR WEDGE

Objective:

To determine the thickness (or diameter) of a thin wire.

Principle:

The air wedge pattern is formed due to the superposition of reflected lightfrom the top of the wedge plane and the bottom plane. The thickness or diameter ofthe given thin wire is given by the formula,

$$d = \frac{Lh}{2\beta},$$

where L-length of the wedge, λ - wavelength of light and β - fringe width.

Materials & Methods:

Air wedge apparatus set up, travelling microscope, sodium vapour lamp,given wire etc.

1. The experimental set up is as shown in the figure.
2. Length of the wedge (L) from the joined end of the two glass plates to the position of the given wire is measured.
3. Eye piece of the microscope is adjusted to get awelldefined pattern of the interference fringes.
4. Moving the microscope horizontally in one direction, the vertical cross wire is made to coincidewith any one of the dark rings,say ‘n’ and the microscope reading is noted.
5. The microscope is moved then to n+5, n+10etc upto say n+25 and readings are taken in each case.
6. From these readings,width of 5 fringes and hence the fringe width(β=x/5) are calculated.
7. Thus knowing β, λ and L, the diameter (d) of the given wire is calculated.

Result:

The diameter of the given thin wire =

Conclusion:

Equally spaced clear interference fringes are seen in the field of view.

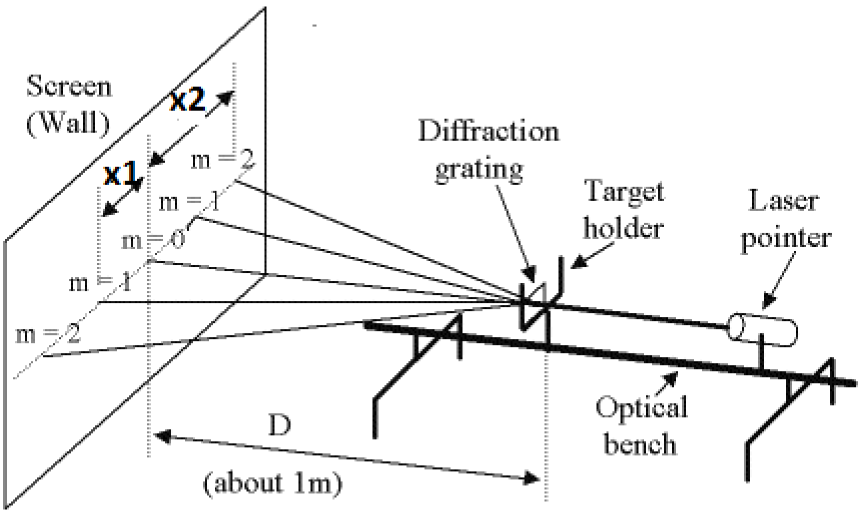


Fig.1 – Determination of wavelength of a laser

5. LASER

Objective:

To determine the wavelength of the given Laser source.

Principle:

When a laser light incident on a plane transmission grating, the diffraction phenomenon occurs. From the diffraction pattern, the wavelength of the laser light can be calculated using the grating equation,

$\sin\theta = nN\lambda$,

where λ – wavelength of the laser light., n – order of diffraction pattern,N –No:of

lines per cm of the grating, θ – Angle of diffraction.

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

Materials & Methods:

Laser source, metre scale,grating, screen etc.

1. Experimental arrangement is as shown in the figure.
2. The grating is mounted on a stand and placed between the laser source andthe screen.
3. The position of the screen is adjusted to get a well defineddiffraction patternof various orders on the screen.
4. The position of the central maxima and its distance from the grating (D) isnoted.
5. The positions of 1^{st}, 2^{nd},3^{rd}etc orders of maxima on either side of the centralmaxima are noted.
6. From these readings the distance between the central maxima and othermaxima (x) are found out.
7. The angle of diffraction,θ= { } { $\frac{x}{D}$ is calculated.
8. Knowing θ, n and N the wavelength λ is calculated using the formula givenabove.
9. The experiment can be repeated for other values of D.

Observations

No. of lines/cm of grating, N =

Trial No.	Distance b/w grating & screen D cm	Order of diffr-action n	Position of central maxima A	Position of diffraction maxima, B		Distance b/w central maxima & diffraction maxima, x= A - B cm			Angle of diffraction, $\theta = \{\frac{x}{D}\}\{180\}$	$\lambda = \frac{\sin\theta}{Nn}$
				Left	Right	Left	Right	Mean		

Wavelength of laser, λ =

Result:

The wavelength of laser =

Conclusion:

Well defined diffraction pattern of the laser light are viewed on the screenand its wavelength is determined. .

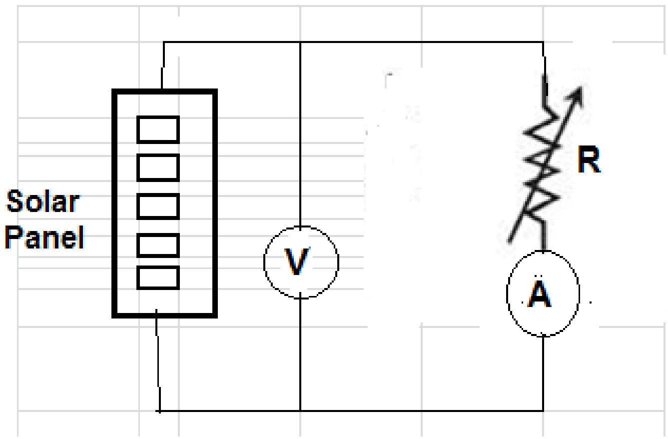


Fig.1 – Circuit diagram

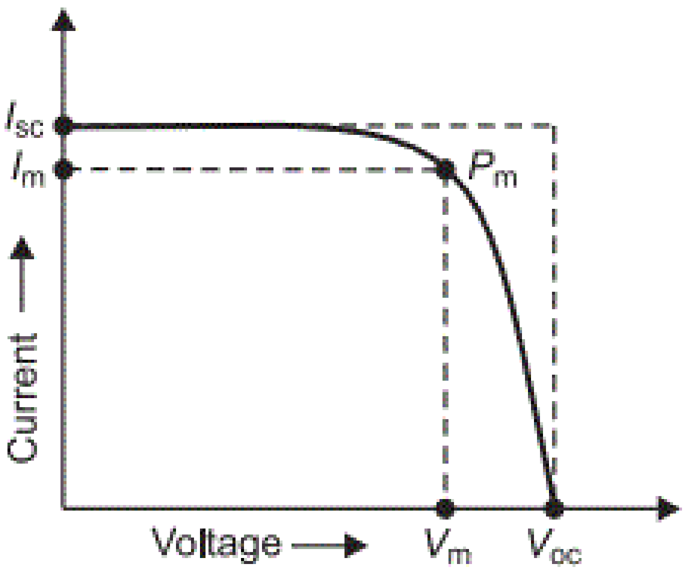


Fig.2 – I-V Characteristics

6. SOLAR CELL

Objective:

To study the V-I characteristics of Solar cell.

Principle:

Photovoltaic effect is the working principle. When light incident on the solar cell electron-hole pairs are produced. The electric field at the junction due to barrier potential, drift the positively charged holes to the P-region and negatively charged electrons to the N-region. Thus accumulation of charges takes place on either side of the pn junction.

I_{sc}- short circuit current at zero bias voltage. V_{oc} –

open circuit voltage for zero current.

Fill factor $= \frac{V_m I_m}{V_{oc} I_{sc}}$

Materials & Methods:

Solar cell, resistance box, voltmeter, ammeter, connection wires etc.

1. Experimental arrangement is as shown in the figure.
2. Sun light is allowed to fall on the solar cell.
3. Current at zero load resistance is noted (I_{sc}).
4. Load resistance is increased in steps, say 50 ohms.
5. The current and voltage are noted for each resistance value.
6. $V_{oc}$is noted (open circuit voltage in sun light).
7. A graph is plotted with voltage against current.
8. I_m and V_m are calculated for maximum power.
9. Fill factor is calculated using the formula given above

.

Observations

Least count of Voltmeter =

Least count ofAmmeter =

Trial No.	Resistance (ohms)	Ammeterreading (mA)	Voltmeterreading (V)	Power (μW)

Short circuit current = I_{SC} = ... mA

Open circuit voltage= V_{OC} =.........Mv

V_m

=I_m

=

Ideal power = V_{OC} xI_{SC} =........... μW

Useful power= V_m x I_m =........... μW

Fill factor $= \frac{V_m I_m}{V_{OC} I_{SC}} =$

Result:

Fill factor =

Conclusion:

Solar cell characteristics are drawn. Short circuit current and open circuit voltage are determined, useful power and ideal power calculated. Fill factor is determined

Date :...................

Expt. No: 7

NUMERICAL APERTURE

OBJECTIVE :

To find the numerical aperture of the given optical fibre using laser light.

PRINCIPLE :

Optical fibres are used to transport light waves by total normal reflection. The core and cladding are made up of glass or plastics with different ref. indices n1 and n2
Numerical aperture is defined as sine of the acceptance angle

$$NA = \sin\Theta = \sqrt{n_1^2 - n_2^2}$$

$$\sin\Theta = \frac{D/2}{\sqrt{L^2 + D^2/4}} = \frac{D}{\sqrt{4L^2 + D^2}}$$

D - Diameter of the ring
L - Distance between optical fibre and screen

MATERIALS AND METHODS

1. Semiconductor diode laser or He-Ne laser
2. Optical fibre of sufficient length
3. Stand with graph/circle drawn on fixed screen
4. Travelling microscope for measuring diameter of the circles drawn.

The experimental procedure adopted for finding NA is as follows

1. One end of the optical fibre is inserted on the laser output without leakage.
2. The other end of the optical fibre is adjusted against a graph or screen.
3. The distance between screen and the tip of the optical fibre is adjusted so that laser light just cover the first circle.
4. The distance between the screen and the optical fibre is noted.
5. The experiment is repeated for filling the second circle, third circles, etc. and take measurement.
6. The radius of the circles are measured by using travelling microscope or scale

RESULT AND DISCUSSION

The numerical aperture =
The acceptance angle =
The accuracy of this experiment depends on the correct judging of the spreading of laser on the screen and measurement.

CONCLUSIONS

This method is not so accurate. But it is the easiest method of finding the NA and acceptance angle.

❖ ❖ ❖

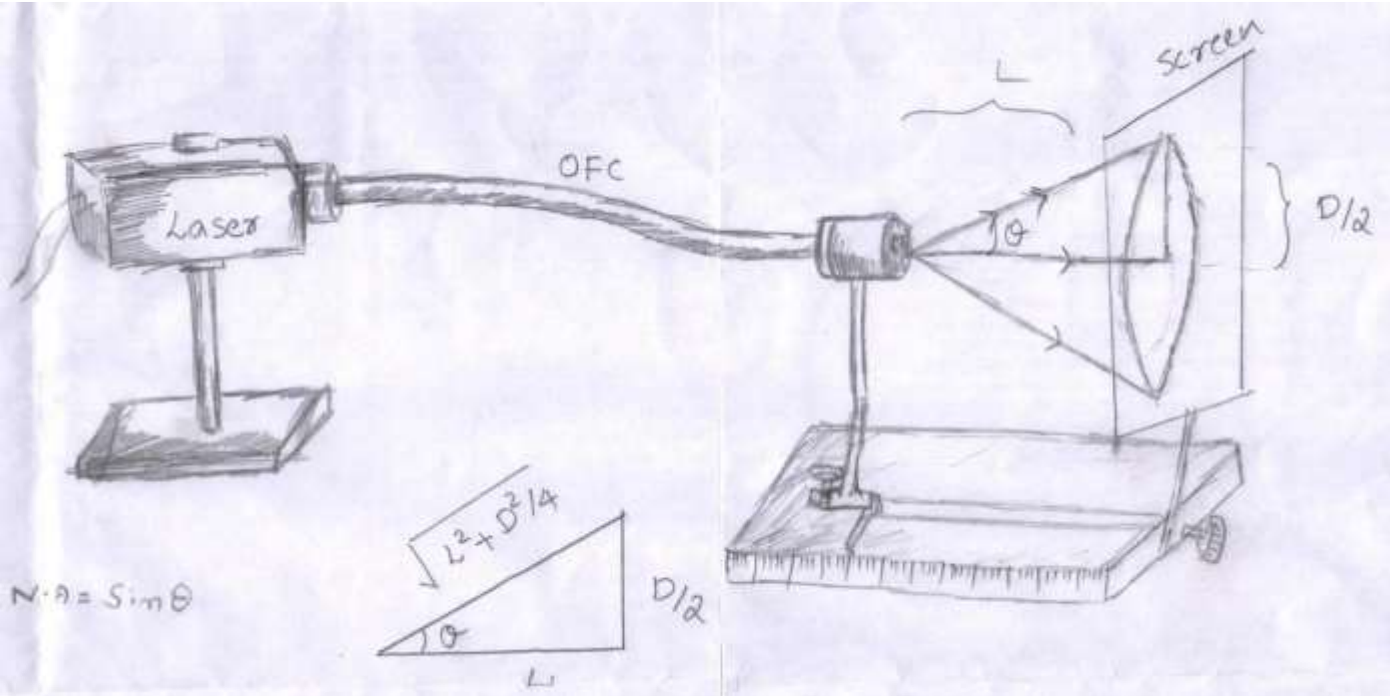


DIAGRAM OF OPTICAL FIBRE ARRANGEMENT

Table 1. Determination of the acceptance angle and

Sl No.	No. of circles	Distance between optical fibre & screen	Diameter of the circle (cm)	Angle in Radiance	Angle in Degrees	N.A=

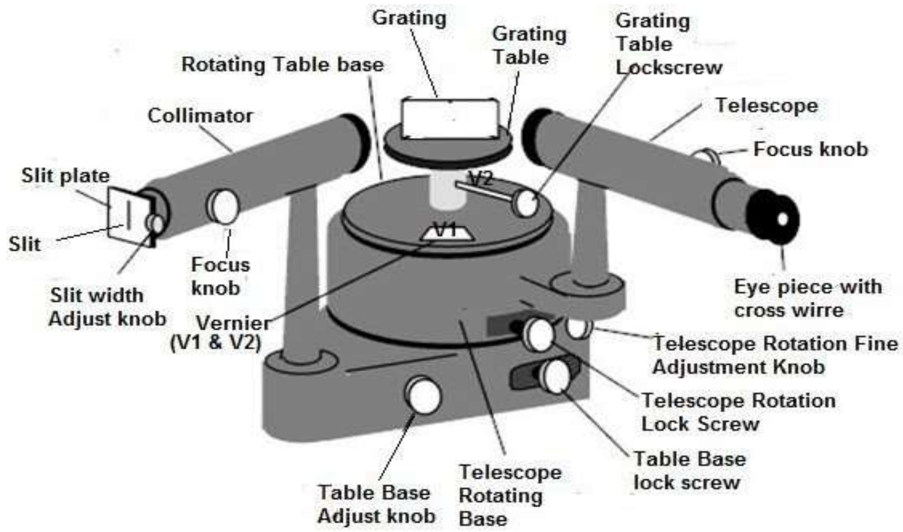


Fig.1 – Spectrometer

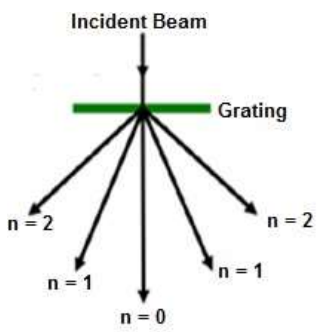


Fig.2 – Orders of spectrum

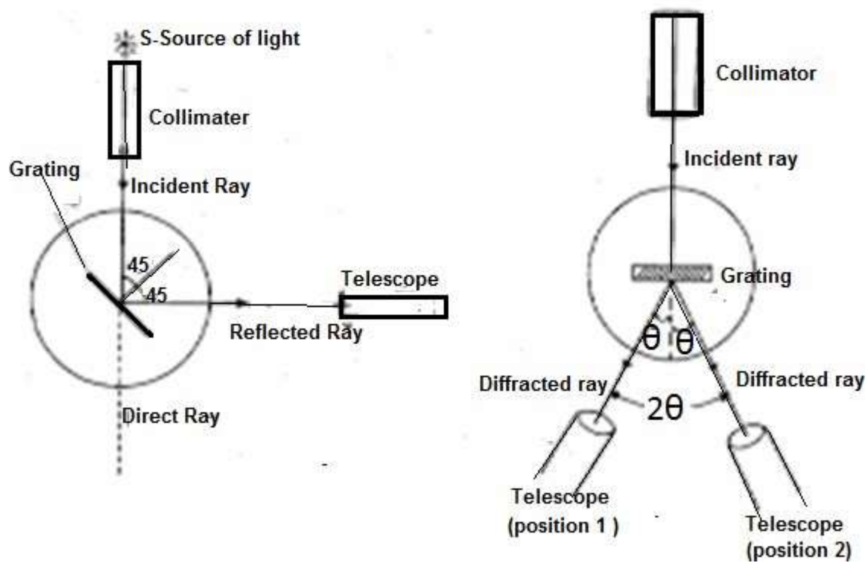


Fig.3 – Normal incidence setting

8.SPECTROMETER-I

Objective:

To standardize the grating using mercury green spectral line and determine the wavelength of a monochromatic light (sodium yellow light) bynormal incidence.

Principle:

Grating is set for normal incidence. Light when incident normally on the grating, diffraction occurs. Grating equation is

$\sin \theta = nN\lambda$

where, λ – wavelength of the laser light.,n –

order of diffraction pattern,

N – No:of lines per cm of the grating,θ –

Angle of diffraction.

Hence wavelength of sodium light, $\lambda = \frac{\sin \theta}{Nn}$

Materials & Methods:

Spectrometer, plane transmission grating, mercury vapour lamp, sodiumvapour lamp, reading lens etc.

A. *Preliminary adjustments of the spectrometer*

1. The telescope is focused by distant object method for parallel rays.
2. The eye piece in the telescope is adjusted so that the cross wire is seenclearly.
3. The telescope is brought in line with the collimatorand themercury lamp.
4. The collimator slit is illuminated by mercury vapour lamp.
5. The collimator slit width is adjusted to allow sufficient amount of light topass through (the slit is made sufficiently narrow).
6. The slit and the lens in the collimator is adjusted to get clear image of the slit.
7. Leveling of the grating table is done with the help of spirit level.
8. The direct image of the slit is viewed through the telescope.

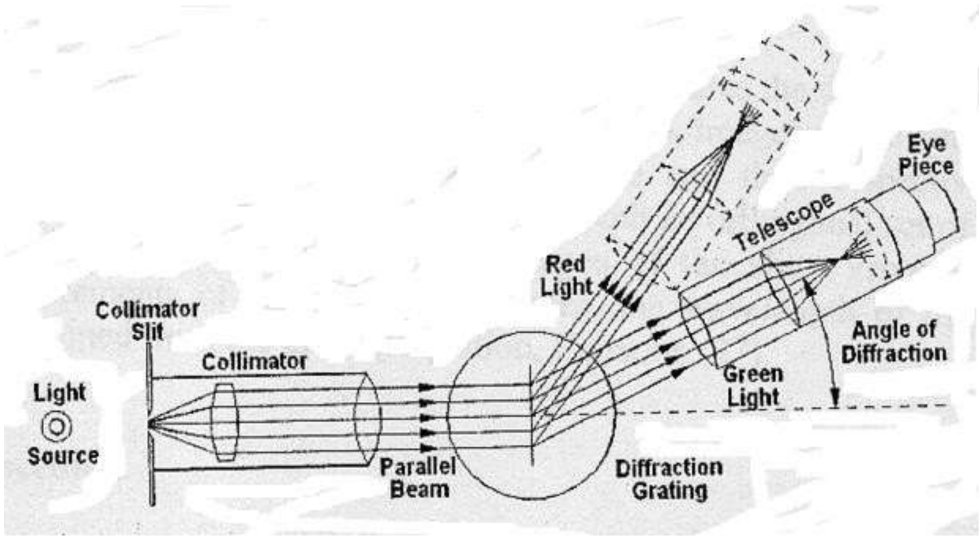


Fig.4 – Diffraction grating-Spectral lines

Observations

1. *To find Least Count (LC)*

One Main Scale Reading (MSR) =

No. of Vernier Scale Division

(VSD) =LC = one MSR / No. of

VSD =

TOTAL = MSR + (VSD x LC)

2. *Standardization of mercury Green light*

Wavelength of Green light, λ =546 nm

Order of Spectrum, n =1

Vernier	Spectrometer Readings						Differenc eb/w A & B=2θ	Angle of diffract ionθ	N = $\frac{\text{Sin }\theta}{nh}$
	Left			Right					
	MSR	VSD	TOTAL= A	MSR	VSD	TOTAL= B			
V1									
V2									

B. *Setting the grating for normal incidence*

9. The telescope and the collimator are now in line and the direct image of the slit is focused on the vertical cross wire.
10. The vernier reading (V1 or V2) is noted. 11.The telescope is rotated through 90^o and fixed.
12. The grating is now mounted on the grating table such that the plane of the grating is perpendicular to the parallel rays coming through the collimatorslit.
13. The grating table alone is now rotated slowly until the reflected image of the slit is exactly at the vertical cross wire.
14. Now the vernier table is rotated through 45^o or 135^o. 15.The grating surface is now set for the normal incidence

C. *To standardize the grating*

16. Telescope is again brought in line with the collimator to view the directimage of the slit.
17. The telescope is slowly turned to the left of the direct image until the firstorder spectrum is seen.
18. The vertical cross wire is made to coincide with the mercury green line of thespectrum.
19. Readings of both the verniers (V1 & V2) are taken..
20. The telescope now slowly turned to the right of the direct image until the firstorder spectrum is seen.
21. The vertical cross wire is made to coincide with the mercury green line of thespectrum.
22. Readings of both the verniers (V1 & V2) are taken..
23. The difference b/w these two readings gives 2θ and hence θ is found out 24.Knowing the wavelength of green light, λ=546 nm , θ, and n the no.of lines per cm of the grating (N) is calculated.

D. *To find wavelength of Sodium light*

25. Mercury vapour lamp is replaced by Sodium vapour lamp and the proceduregiven in *C*(Sl.No.15 to 22) is repeated.
26. Knowing N, n and the angle of diffraction θ, the wavelength, λ of sodiumlight is found out..

3. *Wavelength of Sodium light*No.

of lines per cm of grating, N =

Order of the spectrum, n = 1

Colour of light	Ver-nier	Spectrometer Readings						Differenc e b/w A&B=2θ	Angle of diffraction θ	$\lambda = \frac{\sin\theta}{Nn}$
		Left			Right					
		MSR	VSD	TOTAL=A	MSR	VSD	TOTAL=B			
Yellow1 (Y1)	V1									λ1=
	V2									
Yellow2 (Y2)	V1									λ2=
	V2									

Wavelength of Sodium light,

Yellow1=λ1 =

Yellow2=λ2 =

Hence Wavelength of Sodium light = $\lambda = \frac{(\lambda_1 + \lambda_2)}{2}$ = _____

Result:

The no. of lines per cm of the grating, N =

Wavelength of Sodium light, λ =

Conclusion:

After setting the grating for normal incidence, it is standardized with mercury green light and the wavelength of sodium light is determined which is almost in good agreement with theoretical value of wavelength sodium light.

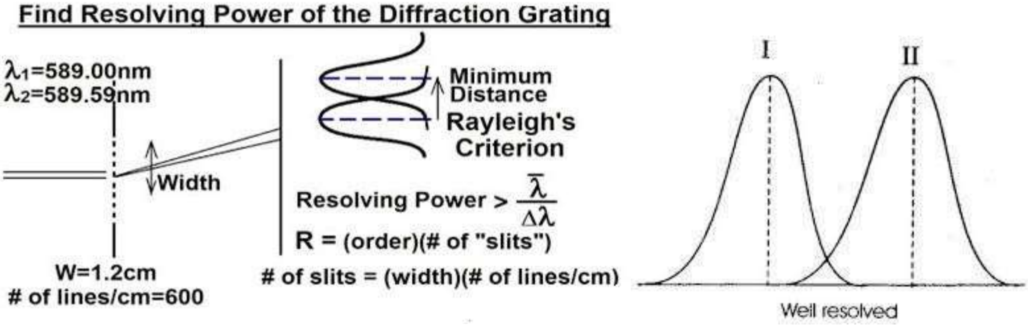


Fig.1. Resolved Images of Spectral lines

Observations

1. To find Least Count (LC)
One Main Scale Reading (MSR) =
No. of Vernier Scale Division
(VSD) =LC = one MSR / No. of
VSD =

TOTAL = MSR + (VSD x LC)

2. *Wavelength determination* No.
of lines per cm of grating, N =
Order of the spectrum, n = 1

Colour of light	Vernier	Spectrometer Readings						Difference b/w A & B=2θ	Angle of diffraction θ	$\lambda = \frac{\sin\theta}{Nn}$
		Left			Right					
		MSR	VSD	TOTAL=A	MSR	VSD	TOTAL=B			
Blue	V1									
	V2									
Green	V1									
	V2									
Yellow1 (Y1)	V1									λ1=
	V2									
Yellow2 (Y2)	V1									λ2=
	V2									

9. SPECTROMETER-II

Objective:

To determine the Dispersive power and Resolving power of a planetransmission grating by normal incidence method.

Principle:

. Grating equation is $\sin\theta = nN\lambda$

where, λ – wavelength of the laser light., n – order of diffraction pattern,N – No:of lines per cm of the grating, θ –Angle of diffraction.

Hence wavelength of sodium light, $\lambda = \frac{\sin\theta}{Nn}$

Dispersive power of grating $= \frac{d\theta}{d\lambda} = \frac{Nn}{\cos\theta}$

Resolving power of grating $= \frac{\lambda}{d\lambda}$

Where $\theta = \left\{\frac{\theta_1 + \theta_2}{2}\right\}$ and $d\theta = |\theta_2 - \theta_1|$,

$\lambda = \left\{\frac{\lambda_1 + \lambda_2}{2}\right\}$ and $d\lambda = |\lambda_1 - \lambda_2|$

Materials & Methods:

Spectrometer, plane transmission grating, mercury vapour lamp, reading lens etc.

1. Preliminary adjustments of the spectrometer are done *(Refer Expt.8).*
2. Grating is set for normal incidence *(Refer Expt.8).*
3. Angles of diffraction and wavelengths for Yellow1 and Yellow2 of the firstorder spectrum are found out *(Refer Expt.8).*
4. Dispersive power and Resolving power of grating are determined using theformula given above.

3.Dispersive power & Resolving power calculation.

Sl.No.	θ1	θ2	$\theta = (\theta 1 + \theta 2)/2$	$d\theta = \theta 2 - \theta 1$	λ1	λ2	$\lambda = (\lambda 1 + \lambda 2)/2$	$d\lambda = \lambda 1 - \lambda 2$

Dispersive power of grating

$$\frac{d\theta}{dh} = \{ \frac{2 - \theta 1}{|h1 - h2|} \} =$$

$$\frac{Nn}{\cos\theta} =$$

Resolving power of grating= $\frac{h}{dh} = \frac{(h1+h2)/2}{|h1 - h2|} =$

Result:

Dispersive power of

grating =Resolving

power of grating =

Conclusion:

The wavelengths of the spectral lines are found out by measuring the angles of diffraction from which the dispersive power and resolving power of grating are determined.

1. S. K. Gupta, “Engineering physics practicals”, Krishna Prakashan Pvt. Ltd., 2014

2. P. R. Sasikumar “Practical Physics”, PHI Ltd., 2011.