**Program Outcomes (POs)**

Engineering Graduates will be able to:

* **PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
* **PO2. 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.
* **PO3. 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.
* **PO4. 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.
* **PO5. 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.
* **PO6. 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.
* **PO7. 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.
* **PO8. Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.
* **PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
* **PO10. 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.
* **PO11. 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.
* **PO12. 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.

**Lab Objectives**

.

|  |  |
| --- | --- |
| 1. | To make the students gain practical knowledge, which are correlated with theoretical studies. |
| 2. | To improve ability to analyze experimental result and write laboratory report. |
| 3. | To achieve perfectness in experimental skills to bring more confidence. |
| 4. | To develop and implement practical applications in modern technology. |

**Lab Outcomes**

|  |  |  |  |
| --- | --- | --- | --- |
| At the end of the laboratory course student will be able to: | | Action verb | Bloom’s Level |
| FEL201.1 | Perform the experiment based on the diffraction of light to measure the wavelength of light using a diffraction grating. | Perform | Applying  Level 3 |
| FEL201.2 | Perform the experiment based on laser light to determine the number of lines/cm on various types of grating and find the divergence of the laser beam. | Perform | Applying  Level 3 |
| FEL201.3 | Perform the experiment using optical fiber to measure the numerical aperture of a given fiber. | Perform | Applying  Level 3 |
| FEL201.4 | Perform experiments on nanotechnology using open source simulation software like Avogadro to draw different carbon structures. | Perform | Applying  Level 3 |
| FEL201.5 | Perform the experiments on physics of sensors to study the I-V characteristics of a Photodiode and measure the distance using an ultrasonic distance meter. | Perform | Applying  Level 3 |
| FEL201.6 | Design and implement a mini-project related to physics | Design | Designing  Level 3 |

**Engineering Physics-II**

**List of experiments**

1. Determination of wavelength using Diffraction grating (Hg/Na source)
2. Determination of number of lines on the grating surface using LASER Source.
3. Determination of Numerical Aperture of an optical fibre.
4. Determination of wavelength using Diffraction grating. (Laser source)
5. Study of divergence of laser beam.
6. Determination of width of a slit using single slit diffraction experiment (laser source)
7. Study of I-V characteristics of Photo diode.
8. Study of ultrasonic distance meter/ interferometer.
9. Study of PT100 calibration and use and thermometer.
10. Study of J /K type thermocouple, calibration and use and thermometer.
11. Simulation experiments based on nanotechnology using open source simulation softwares like Avogadro, Chimera, JMOL etc.

**Engineering Physics-II**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Title of experiments** | **Page**  **No.** | **Date of Performance** | **Date of**  **Submission** | **Marks** | **Sign** |
| **1.** | Plane diffraction grating |  |  |  |  |  |
| **2.** | Diffraction using laser beam |  |  |  |  |  |
| **3.** | Numerical aperture of optical Fiber |  |  |  |  |  |
| **4.** | Study of divergence of Laser beam |  |  |  |  |  |
| **5.** | Study of I-V characteristics of Photo diode |  |  |  |  |  |
| **6.** | Study of ultrasonic distance meter/ interferometer. |  |  |  |  |  |
| **7.** | Simulation of different carbon structures using Avogadro software. |  |  |  |  |  |

**Index**

**INSTRUCTIONS FOR STUDENTS**

* **General Information**

**Some of the purpose of conducting experiments can be enumerated as below:**

* To get familiarized with the basic components, measuring instruments, work bench, and basic machines.
* Observing basic phenomena and characteristics of machine.
* Reporting and analyzing the observations.
* Verify observations, basic rules and understanding physical concepts.
* Hands-on experience on machines.
* Observing safety and developing group-working culture.

***To make laboratory experiments safe and effective, each student must obey the following rules.***

* + **Dress:**
* Boys: Loose clothes not allowed. Shirt should be tucked-in properly, shoes with rubber sole, no slippers are allowed in the lab.
* Girls: Skirts with large flares not permitted, shoes with the rubber sole, no slippers are allowed in the lab.
  + **Attendance:**
* All students are required to attend and contribute adequately while performing experiments in the group. Performance will be judged based on experiments conducted, quality & punctual submission of the lab report for each experiment.
* Faculty will take the attendance. Failure to be present for an experiment will result in losing entire marks for the corresponding experiment. However, genuine cases may be considered to repeat the experiment.
* Students must not attend a different lab group/section from the one assigned at the beginning of the class (unless otherwise approved by the instructor).
* If a student misses a lab session due to unavoidable circumstances, can provide a legitimate proof as soon as possible, he/she may then be allowed by the lab instructor, to make-it-up with a different section.
  + **Preparation and Performance:**
* Before leaving the laboratory, each student must ask the lab instructor for the experiment number to be conducted on the next lab turn, so that the students come prepared after reading and reviewing the reallocated experiment.
* Faculty might check your preparedness and understanding of the experiment and failure to satisfactory reply may de-bar you from conducting the experiments.
* Record your observations in the Lab Manual’s observation tables and do the calculations within the space provided. Do not hesitate to clear any of your doubts concerning the experiments.
* Leave the work place clean after you have finished with your experiments. Dismantle the circuit and put all the wires and equipment back at its original place.
* **General working discipline in the Lab:**

**Students are advised to strictly follow the instructions given below while working in Lab**:

1. Attendance in the laboratory is mandatory.
2. Students should wear an ID card issued by college around their neck when they are in lab.
3. Students will not be allowed after 5 minutes from the scheduled time.
4. No student will leave the Lab without permission.
5. Students should bring their Lab Manuals whenever they come in the lab.
6. Any confusion may be clarified from the faculty at the time of experimentation.
7. Students must maintain discipline and silence in the lab.
8. Students are to remain within their allotted experimental area.
9. Student should be attentive all the time.
10. Follow the instructions given by the faculty or course instructor.
11. Failure to obey safety rules may result in the disciplinary action.
    * **Completion of Manual/journal**

* Manual/journal should be completed as per the guidelines and deadlines given by the subject teacher.
* Each student is required to complete the manual/journal well in time.
* Manual/journal should be neatly written and duly checked by the subject teacher.
* Questions given under the lab manual should be answered by students in the space provided in the lab manual.
* Individual comments/Notes must be written for the further improvement of the lab manual.

Name: -

Branch / Div: - Roll No: -

Experiment No: 01

**TITLE:** **Diffraction Grating**

Date of Performance:

Date of Completion:

**Rubrics for Assessment of Experiment**

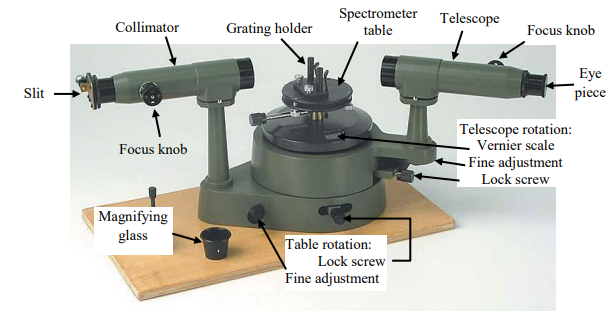
**Performance Indicators for assessing Lab Outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Performance**  **Indicator** | **Exceed Expectations**  **(EE)** | **Meet Expectations**  **(ME)** | **Below Expectations (BE)** | **Marks**  **Obtained** |
| Performance  (03 marks) | *The entire experiment was performed within the assigned time with full attention. ( 03)* | *The entire experiment was executed on the deadline with less attention*  *( 02)* | *The entire experiment was performed beyond the assigned time.*  *(01)* |  |
| Readings, Calculations & Graphs  (03 marks) | *All the readings taken are in the range.*  *All figures & Graphs are correctly drawn &*  *Calculations are done accurately*  *( 03)* | *All the readings taken are not in the range. All figures &, Graphs are correctly drawn but some important features are missing & Calculations are done incorrectly*  *( 02)* | *All the readings are beyond range. All figures & Graphs are poorly drawn & Calculations are done incorrectly*  *(01)* |  |
| Understanding  (02 marks) | *Complete understanding of the aim of the experiment and the basic concepts (02)* | *Incomplete*  *understanding of the aim of the experiment and the basic concepts (01)* | *Very less*  *understanding of the aim of the experiment and the basic concepts (0.5)* |  |
| Timely submission  (02 marks) | *Very neat and complete write-ups submitted on the assigned day.*  *(02)* | *Write-ups submitted late by 2-4 day*  *(01)* | *Write-ups submitted late by 4-6 day*  *(0.5)* |  |
| **Total Marks** | | | |  |

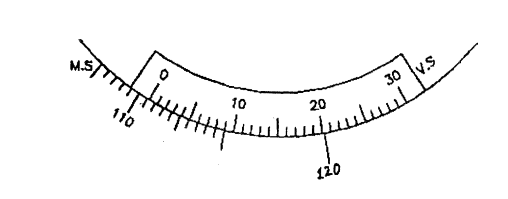
**Experiment No. 1**  **DIFFRACTION GRATING**

**Aim: -** To find the wavelength of a given source using a plane diffraction grating.

**Apparatus**:- Diffraction grating, spectrometer, prism, spirit level, white light source (Mercury vapor lamp).

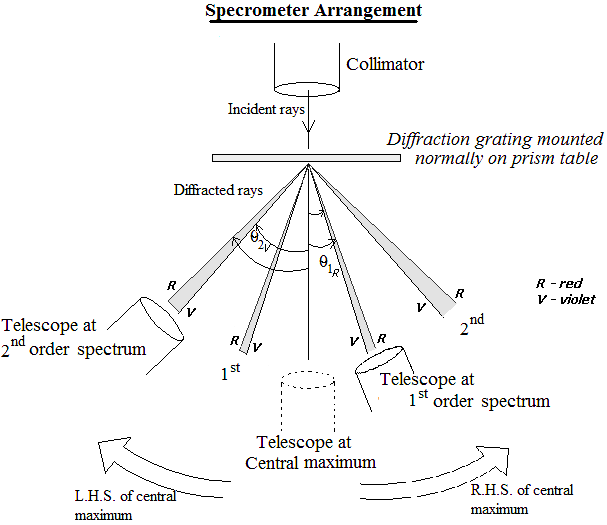


**Figure: 1.** Optical Spectrometer



**Figure: 2.** Readings on the spectrometer scale

**Diagram: -**



**Figure 3:** Schematic diagram of light diffraction by a plane diffraction grating.

**Formula:**  (a + b) sin θ = n λ

*.* Here, N= 1/ (a+b)

The wavelength is given by 

Where *n* **- o**rder of the spectrum

- Wavelength of light

- Diffraction angle for nth order maximum/spectrum

*N*- Number of lines per unit length on grating = \_\_\_\_\_\_\_ = *\_\_\_\_\_\_\_*

**Procedure: -**

1. Do leveling of spectrometer using Schuster’s method for parallel light adjustment. Then do the NORMAL MOUNTING of diffraction grating on prism table. **NOW LOCK THE PRISM TABLE & DON’T LOOSE IT THROUGHOUT THE EXPERIMENT.**
2. Observe central maximum by keeping telescope in line with collimator. Then observe 1st or 2nd order maxima/spectra on both sides of central maximum by moving telescope to both sides. The two yellow lines, two red lines, two green lines, etc. must be clearly visible & parallel to vertical crosswire.
3. Set the telescope on 1st order slit images (i.e.1st order spectrum) on any one side. Coincide vertical crosswire with yellow line (midway between the yellow doublet) & note down spectrometer reading in a considered window. (Take all readings from this window only- V1 or V2). Then coincide vertical crosswire with green, blue and yellow line & note down spectrometer reading.
4. Take similar readings for 1st order spectra on other side of central maximum.
5. From proper tabulation of readings determine diffraction angles θ1 (first order diffraction angle) for respective lines.
6. From the formula, calculate the wavelengths of corresponding lines.

**Observations: -**

Least count of vernier of spectrometer, L.C. 

=  *--------* =  *--------* = \_\_\_\_\_\_

Circular Scale of Spectrometer consists of Main Scale (M.S) and Vernier Scale (V.S)

V.S.R = (C.V.D\* L.C), Where C.V.D = Coincided Vernier Division

Spectrometer reading (TR) = M.S.R. + VSR [Remember 1° = 60’, 1’= 60’’]

**Note**:

1. Main scale reading is the reading of main scale division just to the left of /or coinciding with vernier zero).
2. Coincided vernier division is the number of division of the vernier scale that coincides with some main scale division.

**Observation Table**:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Order of spectrum ‘n’** | **Spectral line / colour in nth order spectrum** | **(Use any one window V1 or V2) Spectrometer reading in window when...** | | | | | | **Angle between spectral images of same order 2n = P ~ Q** | **Diffraction Angle n** |
| **…Telescope at L.H.S. of central maximum ‘P’** | | | **…Telescope at R.H.S. of central maximum ‘Q’** | | |
| MSR | VSR | TR1 | MSR | VSR | TR2 | |TR1-TR2| | |TR1-TR2|/2 |
| 1 | Blue |  |  |  |  |  |  |  | 1B = |
| Green |  |  |  |  |  |  |  | 1G = |
| Yellow |  |  |  |  |  |  |  | 1Y = |

**Calculations: -**

The wavelength can be calculated by 

1. θ1 for Blue =\_\_\_\_\_\_\_\_\_\_

(2) θ1 for Green =\_\_\_\_\_\_\_\_\_\_

(3) θ1 for Yellow =\_\_\_\_\_\_\_\_\_\_

**Result:** -

The wavelengths of the following colours in white light radiation are:

λ blue **=** \_\_\_\_\_\_\_\_\_

λ Green **=**  \_\_\_\_\_\_\_\_\_

λ Yellow **=**  \_\_\_\_\_\_\_\_\_

**Viva Questions:**

1. What is diffraction?
2. What is diffraction grating?
3. What is grating element?
4. Write the formula for secondary maxima and minima for a single slit diffraction.

**Answers:**

**--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------**

Name: -

Branch / Div: - Roll No: -

Experiment No: 02

**TITLE:** **Diffraction using laser beam**

Date of Performance:

Date of Completion:

**Rubrics for Assessment of Experiment**

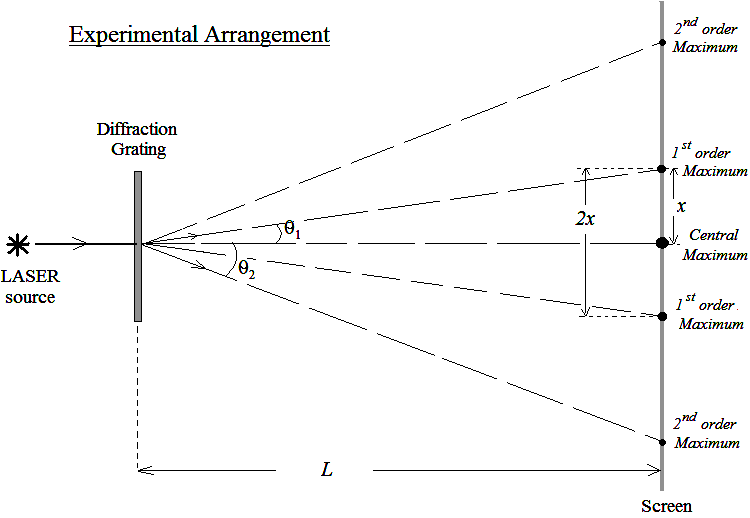
**Performance Indicators for assessing Lab Outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
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| Timely submission  (02 marks) | *Very neat and complete write-ups submitted on the assigned day.*  *(02)* | *Write-ups submitted late by 2-4 day*  *(01)* | *Write-ups submitted late by 4-6 day*  *(0.5)* |  |
| **Total Marks** | | | |  |

**Experiment No. 2 DIFFRACTION USING LASER BEAM**

**Aim: -** To determine element of given diffraction grating through Fresnel’s diffraction of LASER beam.

**Apparatus: -** LASER source, different gratings, scale and screen.

**Diagram: -**

**Figure 4:** Schematic diagram of light diffraction using laser beam.

**Formula:-**

OR

Where *d* - Grating element =1/N

*N* -Number of lines per cm on grating

*n* -Order of maximum in diffraction pattern

*θ* -Angle of diffraction for nth maximum

*λ* -Wavelength of LASER source = 6328

In experimental arrangement, to find angle of diffraction, we have from geometry of arrangement  i.e.

Where, *x* -distance of nth maximum from center of pattern on screen

*L* -distance of screen from grating

**Precaution: -** ***DO NOT DIRECTLY LOOK INTO THE LASER BEAM***.

**Procedure: -**

1. Allow the beam to fall on the grating and the diffraction pattern, in the form of series of dots is observed on the screen placed at a fixed distance ‘L’. In the diffraction pattern, you will observe central or zeroth maximum as brightest spot & on its both sides other spots as 1st, 2nd, etc ordered maxima. You may notice the decrease in the irradiance as you move away from the zero order towards the higher order.
2. Measure the distance (*L*) between the screen and grating.
3. The distance between two first orders dots (*2x*) obtained on both sides of central spot is measured with the help of meter scale.
4. Similarly measure the distance between the two-second order dots obtained on both sides of central spot.
5. Repeat above steps for other grating having different grating element.
6. Tabulate all the readings. Find angle of diffraction in each case so as to find out number of lines per cm (*N*) on each grating. Hence, determine grating element (*d*) in each case.

**Observations**: -

Distance of screen from grating, L = \_\_\_\_\_\_\_\_\_ cm

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Grating** | **Order of maximum**  **‘n’** | **Distance**  **2x (*cm*)** | **x (*cm*)** |  |  | ***( lines / cm )*** |
| I | 1st |  |  |  |  |  |
| 2nd |  |  |  |  |  |
| II | 1st |  |  |  |  |  |
| 2nd |  |  |  |  |  |
| III | 1st |  |  |  |  |  |
| 2nd |  |  |  |  |  |

**Calculations: -**

**For gating-I,** mean N = \_\_\_\_\_\_\_\_\_\_\_\_\_ lines /cm

Hence grating element,  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**For gating-II,** mean N = \_\_\_\_\_\_\_\_\_\_\_\_ lines /cm

Hence grating element,  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**For gating-III**, mean N = \_\_\_\_\_\_\_\_\_\_\_\_ lines /cm

Hence grating element,  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Result: -**

|  |  |
| --- | --- |
| ***Grating*** | ***Grating element ‘d’ (in )*** |
| I |  |
| II |  |
| III |  |

Comparison of all three grating elements with the wavelength of incident light (λ = 6328), describes how diffraction effect becomes dominant with lower & lower dimensions of the diffracting object.

**Viva Questions:**

1. What is LASER?
2. What is stimulated emission?
3. What is laser action?
4. Why does red color deviate the most in case of grating?
5. What gives a more intense spectrum, prism or grating?

**Answers:**

**----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------**

Name: -

Branch / Div: - Roll No: -

Experiment No: 03

**TITLE:** **Numerical aperture of optical fibre**

Date of Performance:

Date of Completion:

**Rubrics for Assessment of Experiment**

**Performance Indicators for assessing Lab Outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Performance**  **Indicator** | **Exceed Expectations**  **(EE)** | **Meet Expectations**  **(ME)** | **Below Expectations (BE)** | **Marks**  **Obtained** |
| Performance  (03 marks) | *The entire experiment was performed within the assigned time with full attention. ( 03)* | *The entire experiment was executed on the deadline with less attention*  *( 02)* | *The entire experiment was performed beyond the assigned time.*  *(01)* |  |
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| Timely submission  (02 marks) | *Very neat and complete write-ups submitted on the assigned day.*  *(02)* | *Write-ups submitted late by 2-4 day*  *(01)* | *Write-ups submitted late by 4-6 day*  *(0.5)* |  |
| **Total Marks** | | | |  |

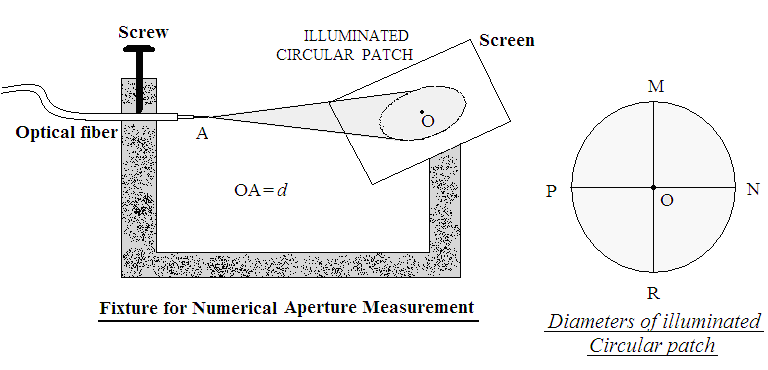
**Experiment No. 3 NUMERICAL APERTURE OF OPTICAL FIBER**

**Aim:** - To measure the numerical aperture of the optical fiber provided with the kit using 660 nm wavelengths LED.

**Apparatus: -** Optical Fiber Experiment kit, holding fixture, ruler, graph-screen.

**Theory**: - Numerical aperture refers to the maximum angle at which the light is incident on the fiber end, suffers total internal reflection and is transmitted properly along the fiber. The cone formed by the rotation of this angel along the axis of fiber, is the cone of acceptance of the fiber. The light ray should strike the fiber end, within this cone of acceptance, else it is refracted out of the fiber & could not be transmitted through it.

**Diagram:**-



**Figure 5:** Schematic diagram for measurement of numerical aperture of optical fiber.

**Procedure: -**

1. Insert the other end of the fiber into the numerical aperture measurement jig. Hold the white sheet/ graph sheet, facing the fiber. Adjust the fiber such that its cut face is perpendicular to the axis of the fiber.
2. Keep the distance of about 50 mm between the fiber tip and the sheet screen.
3. Now observe the illuminated circular patch of the light on the screen.
4. Measure exactly, the distance‘d’ between fiber tip & the screen.
5. Outline the illuminated circular patch on the screen. Remove the screen & measure the vertical and horizontal diameters, MR and PN of the spot, as shown in the above figure.
6. Mean radius of patch can be calculated as, 
7. Find the numerical aperture of the fiber , using formula



where is the maximum angle at which if the light is incident, it is properly transmitted through the fiber.

**Observation Table**:-

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Obs**  **No.** | **Distance of screen from fiber tip**  ***‘d’* cm** | **For the illuminated patch on screen** | | |  | **Angle of cone of acceptance of fiber** |
| **Horizontal diameter**  **PN = D1 cm** | **Vertical diameter**  **MR = D2 cm** | **Radius**  **cm** |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| **Average** | | | | |  |  |

**Result: -** For the given optical fiber,

* + Numerical aperture = \_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Cone of acceptance (vertex angle) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Viva Questions:**

1. What do you mean by fiber optics?
2. Define Critical angle, angle of acceptance and cone of acceptance.
3. Define Total Internal Reflection (TIR).
4. Give the significance of n2 > n1.

**Answers:**

**------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------**

Name: -

Branch / Div: - Roll No: -

Experiment No: 04

**TITLE:** **Divergence of laser beam**

Date of Performance:

Date of Completion:

**Rubrics for Assessment of Experiment**

**Performance Indicators for assessing Lab Outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Performance**  **Indicator** | **Exceed Expectations**  **(EE)** | **Meet Expectations**  **(ME)** | **Below Expectations (BE)** | **Marks**  **Obtained** |
| Performance  (03 marks) | *The entire experiment was performed within the assigned time with full attention. ( 03)* | *The entire experiment was executed on the deadline with less attention*  *( 02)* | *The entire experiment was performed beyond the assigned time.*  *(01)* |  |
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| **Total Marks** | | | |  |

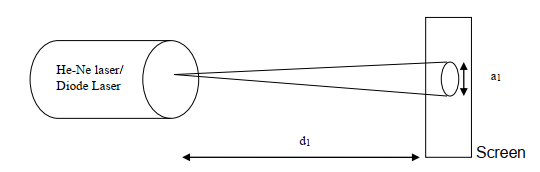
**Experiment No.: 4**

**STUDY OF DIVERGENCE OF LASER BEAM**

**Aim:** -To determine divergence of laser beam.

**Apparatus: -** Laser source, screen, and scale.

**Diagram**:-



**Figure 6**: Light incident on the white screen from a He-Ne Laser source.

**Procedure:-**

1. The laser beam from He-Ne is made to fall on the screen, which is kept at a distance of d1 from the source.
2. The spot size of the beam is noted and is taken as .
3. Now the position of the screen is altered to a new position d2 from the laser source and again the spot size of the beam is noted as .
4. The same procedure is repeated by changing the position of the screen at equal intervals at least 5 times.
5. The readings corresponding to the position of the screen and spot size of  
   the beam is tabulated.
6. From this, the angle of divergence of the laser beam is calculated using the  
   formula .
7. The same can be repeated by using a semiconductor laser diode for the same distances as done with He-Ne laser.

**Observation Table:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sr. N.** | **Position of the screen** | **Diameter of spot (cm)** | **Angle of divergence θ (rad)** | **θ (degree)** | **θ (min)** | **Mean θ**  **(rad)** |
| 1. |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |
| 3. |  |  |  |  |  |  |
| 4. |  |  |  |  |  |  |
| 5. |  |  |  |  |  |  |
| 6. |  |  |  |  |  |  |

**Calculations:**

**Angle of divergence**

**Result:**

**Viva Questions:**

1. What is the cause of divergence of a laser beam?
2. What is the unique property of laser?
3. What is beam profile?

**Answers:**

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Name: -

Branch / Div: - Roll No: -

Experiment No: 05

**TITLE:** **Photo diode I-V characteristics.**

Date of Performance:

Date of Completion:

**Rubrics for Assessment of Experiment**

**Performance Indicators for assessing Lab Outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Performance**  **Indicator** | **Exceed Expectations**  **(EE)** | **Meet Expectations**  **(ME)** | **Below Expectations (BE)** | **Marks**  **Obtained** |
| Performance  (03 marks) | *The entire experiment was performed within the assigned time with full attention. ( 03)* | *The entire experiment was executed on the deadline with less attention*  *( 02)* | *The entire experiment was performed beyond the assigned time.*  *(01)* |  |
| Readings, Calculations & Graphs  (03 marks) | *All the readings taken are in the range.*  *All figures & Graphs are correctly drawn &*  *Calculations are done accurately*  *( 03)* | *All the readings taken are not in the range. All figures &, Graphs are correctly drawn but some important features are missing & Calculations are done incorrectly*  *( 02)* | *All the readings are beyond range. All figures & Graphs are poorly drawn & Calculations are done incorrectly*  *(01)* |  |
| Understanding  (02 marks) | *Complete understanding of the aim of the experiment and the basic concepts (02)* | *Incomplete*  *understanding of the aim of the experiment and the basic concepts (01)* | *Very less*  *understanding of the aim of the experiment and the basic concepts (0.5)* |  |
| Timely submission  (02 marks) | *Very neat and complete write-ups submitted on the assigned day.*  *(02)* | *Write-ups submitted late by 2-4 day*  *(01)* | *Write-ups submitted late by 4-6 day*  *(0.5)* |  |
| **Total Marks** | | | |  |

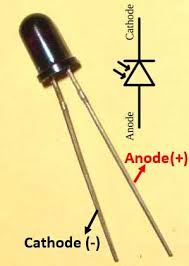
**Experiment No: 5 PHOTODIODE I-V CHARACTERISTICS**

**Aim:** – To study the I-V characteristics of Photodiode.

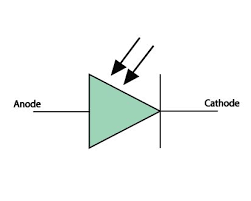
**Apparatus:** – A photodiode kit, connecting wires, source of light etc.

**Theory:** – Photodiode is a form of light-weight sensor that converts light energy into electrical voltage or current. Photodiode is a type of semi conducting device with PN junction. Between the p (positive) and n (negative) layers, an intrinsic layer is present. The photo diode accepts light energy as input to generate electric current.

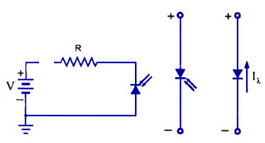
It is also called as Photodetector, photo sensor or light detector. Photo diode operates in reverse bias condition i.e. the p-side of the photodiode is connected with negative terminal of battery (or the power supply) and n-side to the positive terminal of battery. Typical photodiode materials are Silicon, Germanium, Indium Gallium Arsenide Phosphide and Indium gallium arsenide. Few photo diodes will look like Light Emitting Diode (LED). It has two terminals as shown below. The smaller terminal acts as cathode and longer terminal acts as anode.



The symbol of the photodiode is similar to that of an LED but the arrows point inwards as opposed to outwards in the LED. The following image shows the symbol of a photodiode.

****

**Circuit Diagram:**

****

**Figure: 7** Circuit diagram of a photodiode.

**Procedure:**

1. Connect the circuit as shown in fig.
2. Note down corresponding current by varying voltage for a specified distance (‘d’). Repeat the same procedure for different value of distance (‘d’).
3. Plot the graph distance (on X-axis) V/S. current (on Y-axis).

**Observation Table: Part: I (I-V-characteristics)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Obs No.** | **d = 10 cm** | | **d = 15 cm** | | **d = 20 cm** | | **d = 25 cm** | | **d = 30 cm** | |
| **Vs (V)** | **Ir (µA)** | **Vs(V)** | **Ir(µA)** | **Vs(V)** | **Ir(µA)** | **Vs(V)** | **Ir(µA)** | **Vs (V)** | **Ir (µA)** |
| **1** |  |  |  |  |  |  |  |  |  |  |
| **2** |  |  |  |  |  |  |  |  |  |  |
| **3** |  |  |  |  |  |  |  |  |  |  |
| **4** |  |  |  |  |  |  |  |  |  |  |
| **5** |  |  |  |  |  |  |  |  |  |  |
| **6** |  |  |  |  |  |  |  |  |  |  |
| **7** |  |  |  |  |  |  |  |  |  |  |
| **8** |  |  |  |  |  |  |  |  |  |  |

**Part: II**

**Procedure:**

1. Connect the circuit as shown in fig.
2. Note down current for different values of distance keeping voltage constant.
3. Plot the graph distance (on X-axis) V/S current (on Y-axis).

**Observation:**

For Vs =

|  |  |  |  |
| --- | --- | --- | --- |
| **Obs. No.** | **d (cm)** | **1/d2 (cm-2)** | **Ir (µA)** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |

**Graph: - For part I**

Plot the graph of Ir (µA) against Vs (V)

**For part II**

Plot the graph of Ir (µA) against 1/d2 (cm-2)

**Result:-**

**Conclusion: -** The reverse bias current \_\_\_\_\_\_\_ with increasing intensity of light.

**Viva Questions:**

1. What is the difference between normal diode & photo diode?
2. What is the Principle of Photo diode?
3. V-I characteristic of Photo diode?
4. What are the application of Photo diode?

**Answers:**

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Name: -

Branch / Div: - Roll No: -

Experiment No: 07

**TITLE:** **Simulation of Carbon nano-structure**

Date of Performance:

Date of Completion:

**Rubrics for Assessment of Experiment**

**Performance Indicators for assessing Lab Outcomes**

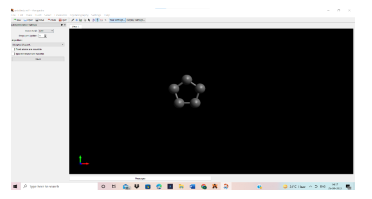
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Performance**  **Indicator** | **Exceed Expectations**  **(EE)** | **Meet Expectations**  **(ME)** | **Below Expectations (BE)** | **Marks**  **Obtained** |
| Performance  (03 marks) | *The entire experiment was performed within the assigned time with full attention. ( 03)* | *The entire experiment was executed on the deadline with less attention*  *( 02)* | *The entire experiment was performed beyond the assigned time.*  *(01)* |  |
| Readings, Calculations & Graphs  (03 marks) | *All the readings taken are in the range.*  *All figures & Graphs are correctly drawn &*  *Calculations are done accurately*  *( 03)* | *All the readings taken are not in the range. All figures &, Graphs are correctly drawn but some important features are missing & Calculations are done incorrectly*  *( 02)* | *All the readings are beyond range. All figures & Graphs are poorly drawn & Calculations are done incorrectly*  *(01)* |  |
| Understanding  (02 marks) | *Complete understanding of the aim of the experiment and the basic concepts (02)* | *Incomplete*  *understanding of the aim of the experiment and the basic concepts (01)* | *Very less*  *understanding of the aim of the experiment and the basic concepts (0.5)* |  |
| Timely submission  (02 marks) | *Very neat and complete write-ups submitted on the assigned day.*  *(02)* | *Write-ups submitted late by 2-4 day*  *(01)* | *Write-ups submitted late by 4-6 day*  *(0.5)* |  |
| **Total Marks** | | | |  |

**Experiment No: 7 Simulation of Carbon Nano-Structure**

**Aim**: To understand and draw carbon-60 structure (Fullerene).

**Apparatus:** Avogadro Software

**Procedure:**1. Download the Avogadro software in computer lab.  
2. Understand the drawing tools of Avogadro software.  
3. Draw the C-60 structure with following steps.  
4. Draw 5 carbon atoms and join them with single bond and use UFF 4 to optimize and  
convert it into regular pentagon.



**Figure: 9** Carbon Structure

1. Do not forget to stop optimization whenever used.
2. Draw 5 hexagons with each side of pentagon and optimize.
3. In the valley formed by each hexagon, draw 5 pentagons by adding 2 carbon atoms each time and optimize.
4. In the valley formed by each pentagon, draw 5 hexagons by adding 2 carbon atoms each time and optimize.
5. In the valley formed by each hexagon, again draw 5 hexagons by adding 2 carbon atoms each time and **but do not optimize**.
6. In the valley formed by each hexagon, now draw 5 pentagons by adding 1 carbon atoms each time.
7. Now optimize and wait for the structure to take shape.
8. Draw five carbon atoms surrounding the central pentagon and join them to complete the pentagon.
9. Join these five carbon atoms to the five topmost carbon atoms.
10. Join these five carbon atoms to the five topmost carbon atoms.
11. This is the C60 Fullerene structure.

**Diagrams of the optimized carbon Nano-structures:**

**Result:**

**Viva Questions:**

1. What are nanomaterials? Give any three properties.
2. Give any two methods of synthesis for nanomaterials.
3. Write down any two applications of nanomaterials.

**Answers:**

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Name: -

Branch / Div: - Roll No: -

Experiment No: 07

**TITLE:** **Ultrasonic distance measurement**

Date of Performance:

Date of Completion:

**Rubrics for Assessment of Experiment**

**Performance Indicators for assessing Lab Outcomes**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Performance**  **Indicator** | **Exceed Expectations**  **(EE)** | **Meet Expectations**  **(ME)** | **Below Expectations (BE)** | **Marks**  **Obtained** |
| Performance  (03 marks) | *The entire experiment was performed within the assigned time with full attention. ( 03)* | *The entire experiment was executed on the deadline with less attention*  *( 02)* | *The entire experiment was performed beyond the assigned time.*  *(01)* |  |
| Readings, Calculations & Graphs  (03 marks) | *All the readings taken are in the range.*  *All figures & Graphs are correctly drawn &*  *Calculations are done accurately*  *( 03)* | *All the readings taken are not in the range. All figures &, Graphs are correctly drawn but some important features are missing & Calculations are done incorrectly*  *( 02)* | *All the readings are beyond range. All figures & Graphs are poorly drawn & Calculations are done incorrectly*  *(01)* |  |
| Understanding  (02 marks) | *Complete understanding of the aim of the experiment and the basic concepts (02)* | *Incomplete*  *understanding of the aim of the experiment and the basic concepts (01)* | *Very less*  *understanding of the aim of the experiment and the basic concepts (0.5)* |  |
| Timely submission  (02 marks) | *Very neat and complete write-ups submitted on the assigned day.*  *(02)* | *Write-ups submitted late by 2-4 day*  *(01)* | *Write-ups submitted late by 4-6 day*  *(0.5)* |  |
| **Total Marks** | | | |  |

**Experiment No.: 6 ULTRASONIC DISTANCE MEASUREMENT**

**Aim:** – To use ultrasonic distance measuring unit for measuring distances.

**Apparatus:** – Ultrasonic Distance Measurer (EUROLAB DIST2)

**Theory:** – Ultrasonic waves travel as a highly directional beam & hence can be used for distance measuring purpose through echo-sounding technique.

One ultrasonic pulse is sent by the instrument & received back after getting rebound at a surface. The time difference between sending instant & receiving instant (echo time) is measured. By knowing velocity of ultrasonic waves in the medium (air), the distance of surface or obstacle from the instrument can be calculated as

Distance 

In an ultrasonic distance measurer, the whole process is done automatically using electronic components & the display of measurer shows directly the distance value.

**Diagram**:-

**Figure: 8** Ultrasonic distance meter block diagram

**Observations:**

Measurement range available with given instrument is **0.91m to 15m**

Measurement of Area & Volume of a Room**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr No.** | **Length** | **Width** | **Height** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| **Average** |  |  |  |

**Results:**

Carpet Area of the room = \_\_\_\_\_\_\_\_\_

Volume of the room space = \_\_\_\_\_\_\_\_\_\_\_\_

**Remarks:** Ultrasonic waves can be used for distance measurement. The Ultrasonic Distance Measurer that we used is ideal for use in building construction & related businesses

**Viva Questions:**

1. How is ultrasonic distance measured?
2. What is the maximum distance the ultrasonic sensor can detect?
3. What is the normal frequency range used for ultrasonic level measurements?
4. What logic is used in ultrasonic distance of object?

**Answers:**

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**Engineering Physics Assignments**

**Assignment No: 1 (Module-1: Diffraction)**

1. Discuss with appropriate diagram the phenomenon of Fraunhofer diffraction at a single slit and write the condition for its maxima and minima.
2. Explain the construction of diffraction grating. What is grating element? How do you measure the wavelength of spectral line in the laboratory using plane transmission grating? Explain.
3. What is Rayleigh’s criterion of resolution? Derive the expression for resolving power of grating.
4. A plane transmission grating having 6000 lines/cm is used to obtain a spectrum of light from a sodium lamp in the second order. Calculate the angular separation between the two sodium lines whose wavelength are 5890 and 5896.

**Assignment No: 2 (Module-2: Laser and Fiber optics)**

1. With neat and labelled diagrams, explain the construction and working of a He-Ne laser.
2. With neat and labelled diagrams, explain the construction and working of a Nd-YAG laser.
3. With neat and labelled diagrams, explain the construction and working of a semiconductor laser. What serves the resonant cavity in semiconductor laser?
4. Derive the expression of numerical aperture for a step index fibre.

**Assignment No: 3 (Module-3: Electrodynamics)**

1. Explain the difference among gradient, divergence and curl of a given function with examples.
2. State and derive Maxwell’s first equation in its differential form and write its integral form.
3. State and derive Maxwell’s third equation in its differential form and write its integral form.
4. State and derive Maxwell’s fourth equation in its differential form and write its integral form. Explain displacement current.

**Assignment No: 4 (Module 4 & 5: Relativity & Nanotechnology)**

1. What is length (space) contraction and Time dilation, obtain expression for them using Lorentz transformation.
2. What is nano-material? Explain Ball milling, sputtering, vapour deposition, and Sol-gel method of synthesis of nanomaterials.
3. Explain construction and working of a Scanning Electron Microscope (SEM).
4. Explain construction and working of the Transmission Electron Microscope (TEM).
5. Explain construction and working of Atomic Force Microscope (AFM).

**Numericals**

1. Calculate the maximum order of diffraction maxima seen from plane transmission grating with 2500 lines per inch if light of wavelength 6900 Å falls normally on it.

(**Ans**: 14)

1. A strong yellow line in the sodium spectrum are at wavelength 5890 Å and 5896 Å. How many rulings are needed in a diffraction grating to resolve these lines in second order? (**Ans**: 491)
2. A light ray enters an optical fiber from air, fibre has core refractive index 1.52 and cladding refractive index 1.41. Find the Critical angle and Numerical aperture.

(**Ans**: 68.06 and 0.5677)

1. A step-index fiber has a core diameter of 29 x 10-6 m. The refractive indices of core and cladding are 1.52 And 1.5189 respectively. If the light of wavelength 1.3 µm is transmitted through the fiber. Determine normalized frequency of the fiber and

number of modes of a step-index optical fibre. (**An**s: 4.026 and 8)

1. If ф(x,y,z) = 3x2y - y3z2, Find **∇**ф at the point (-1, -2, 1) ( **Ans**: 12 - 9 +16 )
2. Find the divergence and curl of a vector **A** = x2 y î + (x-y) k̂.

(**Ans:** 2xy and - - -x2 )

1. A meter scale is projected into space and its length appear to be contracted to 50 cm. what is the velocity with which the scale is projected? (**Ans**: 0.866c)
2. Calculate the speed of electron, which has kinetic energy 1.02 MeV. (**Ans**:0.8911c)