**Experiment: 7**

# DIFFRACTION GRATING

**AIM:** To determine the wavelength of the Laser light using diffraction grating.

**APPARATUS:** Diffraction Grating, meter scale, Diode laser

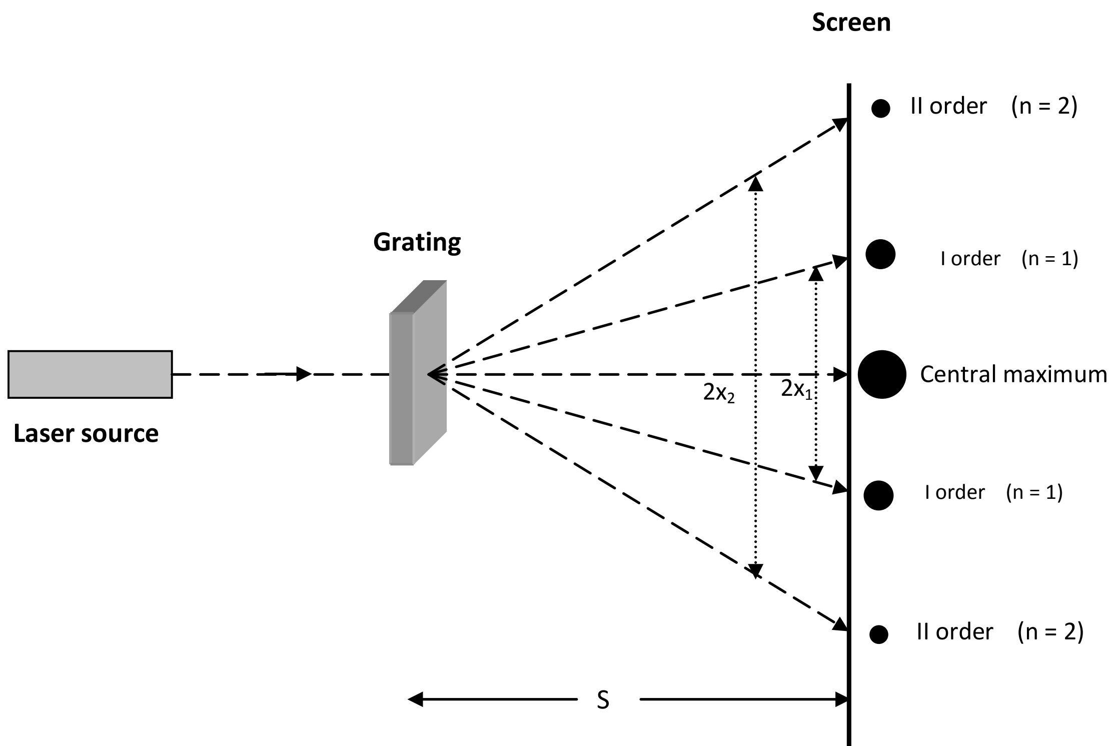
**INTRODUCTION:**

Diffraction is the bending of light waves after they pass through narrow openings (or around the small obstacles).The diffraction of light wave is possible only when the size of the obstacle is of the order of wavelength of incident light. The diffraction pattern consists of variation of intensity of the image being formed.

Laser stands for "light amplification by stimulated emission of radiation". Laser is a special type of light source, which emits a light of high monochromaticity, high directionality, high coherence and high intensity. The emission of laser beam is mainly due to process called stimulated emission. To diffract the laser light, diffraction gratings are used. A diffraction grating is an optically plane glass plate on which a number of equidistant parallel lines are ruled.

When a parallel beam of laser light falls normally on the grating, it diffracts at every slit and interference between these waves gives rise to diffraction pattern with central maxima, I order and II order diffraction as shown in figure.

**RAY DIAGRAM:**



**FORMULAE:**

1. $\lambda = \dfrac{d \sin\theta}{m}$

2. $\lambda = d \cdot \text{slope}$

3. $d = \dfrac{1}{N}$

4. $\theta = \tan^{-1}\left(\dfrac{x_m}{S}\right)$

Where

m is the order of the diffraction

$\lambda$ is the wavelength of the laser in m

d is the grating constant in m

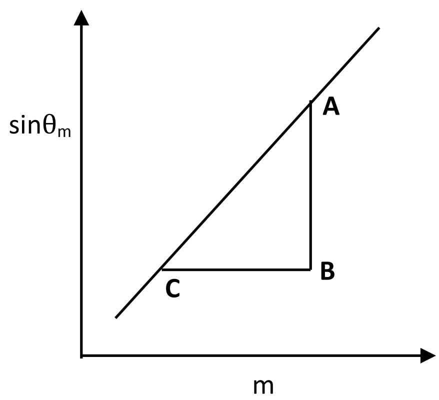
$\theta$ is the angle of diffraction in degree

N is the number of lines per unit length of the grating in $m^{-1}$

$x_m$ is the distance between the central maxima and the $m^{th}$ order in m

S is the distance between the grating and the screen in m

**NATURE OF GRAPH:**




Slope = AB/BC

**TABULAR COLUMN :**

1 inch = 2.54 cm = 0.0254 m

d = $\frac{1}{N}$ = $\frac{0.0254}{500}$ = ………………. m = …………………. nm

| 500 LPI grating, S = …..cm | | | | | |
|---|---|---|---|---|---|
| Order m | $2x_m$ ( cm ) | $x_m$ ( cm ) | $\theta_m = \tan^{-1}\frac{x_m}{S}$ ( degree) | $\sin\theta_m$ | $\lambda = \frac{d \sin\theta}{m}$ ( nm ) |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| | | | | | Average $\lambda$ = nm |

**PROCEDURE:**

1. Arrange the experimental set up as shown in the figure, such that the laser source, 500LPI grating and screen are in the same line.

2. The diffraction pattern of laser light is observed on the screen. Equally spaced light spots are observed. The total numbers of spots are counted. A central bright ray and consecutive dots of higher order (which will be of lesser intensity) are observed on the screen.

3. Set the distance between the plane of grating and the screen (S) as 100 cm. For this particular distance, mark the center of the spots of the diffraction pattern on the screen using a pencil. The distances between consecutive order of diffraction is measured using a scale and tabulated in table.
4. The distance between the two first orders diffraction spots are measured, $2x_1$ cm. Similarly the distance between two second order diffraction spots are measured and recorded in Table, $2x_2$ cm. This is continued up to $8^{th}$ order, $2x_8$ cm.

5. The angles of diffraction for all orders can be calculated using the formula $\theta_m = \tan^{-1}\frac{x_m}{S}$ and the respective wavelengths are calculated using a formula $\lambda = \frac{d \sin\theta_m}{m}$ and the average value of wave length is calculated.

6. A plot of $\sin\theta_m$ against m (order of the spot) is drawn and the slope of the straight line is measured.

7. The wavelength is obtained by the formula $\lambda$ = d x slope
8. The wavelengths obtained from step 5 and steps 8 are to be compared.

**RESULT:**

1. The wave length of the given laser source from calculation is ……………….………..nm
2. The wave length of the given laser source from graphical method is ………………...nm

**Reference:**

1. Optics, Ajoy Ghatak, Tata Mcgraw Hill, 3rd Edn,1991, (Page 325-326)
2. An advanced course in Practical Physics, Chattopadyay, Central Publn, 2002, 6th Edn, (Page 261 – 263)
3. Optics, E. Hecht, Pearson Education 4th Edn, 2002, (Page 476-478)