

Diffraction grating using LASER

Experiment No.: _____

Date: _____

Aim:

To determine the wavelength of LASER by plane diffraction grating.

Apparatus:

- a) Optical bench
- b) Four uprights
- c) Diffraction grating
- d) LASER source
- e) Screen
- f) Convex lens
- g) Graph paper

Theory:

- a) When a parallel beam of monochromatic light is incident normally on a grating, the transmitted light gives rise to primary maxima in certain direction given by the relation

$$(a + b) \sin \theta_n = n\lambda \text{ ----- (1)}$$

Where, a = Width of transparency

b = Width of opacity

$(a + b)$ = Grating element

θ_n = The angle of diffraction for the n^{th} order maxima

λ = Wavelength of light

n = Order of spectrum

So,

$$\lambda = \frac{(a + b) \sin \theta_n}{n}$$

 ----- (2)

- b) If θ_1 & θ_2 are the angles of diffraction in the first and second order spectra respectively, then

$$\lambda = (a + b) \sin \theta_1 \quad \text{and} \quad \lambda = \frac{(a + b) \sin \theta_2}{2}$$

Procedure:

- To one end of the optical bench, He – Ne LASER is placed in between the two rods of optical bench.
- In front of LASER source on one rider optical slit, on another rider optical screen with graph paper are fitted. The heights of all these are adjusted to be the same.
- The optical slit is placed close to the LASER source and its width is kept very small. The rider on which convex lens is fitted, is placed at a distance equal to the focal length of lens from the slit.
- At a few centimetre distances, the rider of the grating and at a comparatively larger distance the rider of optical screen is placed. The slit should be adjusted parallel to the lines and the grating should be normal to the parallel rays coming from lens and optical bench should be levelled.
- While switching on the LASER source, a spectrum is formed on the optical screen. Distances in between slit, grating and the optical screen are adjusted so that well defined spectrum of LASER is obtained on the screen.
- On the optical screen, spectrum of diffraction pattern is formed with maximum at the middle (central maximum) and maxima of increasing order on its either side are formed. The distances of maxima of different order from central maxima are noted from the graph paper of optical screen and noted in the observation table. The positions of riders of grating and the optical screen are also noted.

Observations:

- Position of the rider of diffraction grating (L_1) = cm
- Position of the rider of optical screen (L_2) = cm

Distance between diffraction grating and the optical screen, $X = (L_2 - L_1) = \dots\dots\dots \text{cm}$

No. of lines on grating, 'N' (Per inch) =

Grating element = $(a + b) = \frac{1}{N} = \dots\dots\dots \text{cm per line}$

Table: (Determination of diffraction angle and wavelength)

Order of spectrum	Observation on right side of the central maxima (A)	Observation on left side of the central maxima (B)	Difference $2Y = (A - B)$	$Y = \frac{(A - B)}{2}$	Diffraction angle, $\theta \cong \sin \theta \cong \tan \theta = \frac{Y}{X}$
$n = 1$					
$n = 2$					
$n = 3$					

Calculation of λ :

For first order, $\lambda_1 = \frac{(a+b) \sin \theta_1}{1}$

For second order, $\lambda_2 = \frac{(a+b) \sin \theta_2}{2}$

For third order, $\lambda_3 = \frac{(a+b) \sin \theta_3}{3}$

Mean wavelength, $\lambda = \frac{\lambda_1 + \lambda_2 + \lambda_3}{3} = \dots\dots\dots \text{cm}$

Percentage of Error:

Standard value of wavelength $\lambda = 6328 \text{ \AA}$

& the measured value of $\lambda = \dots\dots\dots \text{ \AA}$

Therefore, % error = $\left| \frac{\text{Standard value} - \text{Measure value}}{\text{Standard value}} \right| \times 100$
 = $\dots\dots\dots$

Precautions:

- a) Height of LASER source, slit, lens, grating and optical screen on all riders should be same.
- b) All riders must be aligned along one common axis.
- c) Slit, grating and optical screen should be vertical and parallel to each other.
- d) Grating should be fixed for normal incidence.
- e) Don't see LASER directly. It is very injurious. Be extremely careful.

Conclusion:

The wavelength of the LASER light was found to be _____ with _____ % of error.

Marks Awarded

Planning and Execution (2)	Result and Report (6)	Viva (2)	Total (10)

Signature of the faculty

Signature of the student:

Regd. No:

Group:

Branch: