EXPERIMENT-5

AIM: To find the wavelength of He-Ne laser source using transmission diffraction grating

APPARATUS: Laser Source with its holder, diffraction grating with its mount, screen, scale and optical bench

THEORY: When monochromatic radiation of wavelength 'lambda' is diffracted by diffraction grating then the n^{th} order principal maxima if formed at angle 'theta' given by:

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

Where $(a+b)$ is grating constant

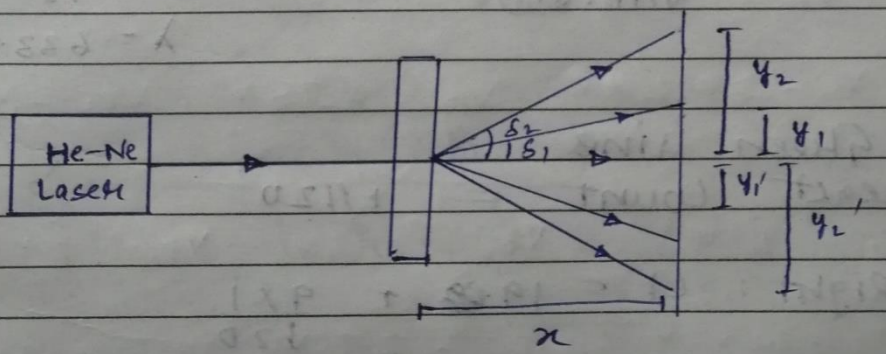
$$(a+b) = \frac{1}{N} \quad (N = \text{No. of lines per inch})$$

$$\therefore \lambda = \frac{\sin\theta_n}{n \cdot N} \text{ inch}$$

$$\Rightarrow \lambda = \frac{\sin\theta_n}{n \cdot N} \times 2.54 \text{ cm (where N is in inch)}$$

OR

$$\lambda = \frac{\sin\theta_n}{n \cdot N} \text{ cm (where N is in cm)}$$



From figure, $\sin\theta_n = \frac{y_n}{\sqrt{x_n^2 + y_n^2}}$

$$\therefore \lambda = \frac{y_n}{\sqrt{x_n^2 + y_n^2}} \cdot \frac{1}{nN}$$

OBSERVATION: Grating sheet=600 lines/mm

Wavelength of he-ne laser(actual) = 632.8nm

S. No	Order of diffraction(n)	Position of screen(x)	Distance from central spot		Sin(theta)	
			Right	Left	Right	Left
1.	1	15.9cm	6.2cm	6.5cm	0.36	0.38
2.	2	15.9cm	18cm	18.5cm	0.74	0.75
3.	1	12cm	5.2cm	5.1cm	0.39	0.39
4.	2	12cm	15cm	14.3cm	0.78	0.76

CALCULATIONS:

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

$\Rightarrow \lambda = \frac{\sin\theta}{600 \cdot n}$ mm

$\Rightarrow \lambda_1 = \frac{0.36\text{ mm}}{600} = 600$ nm ; $\lambda_5 = \frac{0.39\text{ mm}}{600} = 650$nm

$\lambda_2 = \frac{0.38\text{ mm}}{600} = 643$ nm ; $\lambda_6 = \frac{0.39\text{ mm}}{600} = 650$nm

$\lambda_3 = \frac{0.74\text{ mm}}{600 \times 2} = 616$ nm ; $\lambda_7 = \frac{0.78\text{ mm}}{1200} = 650$ nm

$\lambda_4 = \frac{0.75\text{ mm}}{600 \times 2} = 625$ nm ; $\lambda_8 = \frac{0.76\text{ mm}}{1200} = 633$nm

$\lambda_{mean} = \frac{\lambda_1 + \lambda_2 + \ldots + \lambda_8}{8}$

$= 633.75$ nm

% Error $= \frac{633.75 - 632.8}{632.8}$

$= 0.15$ %

RESULT: The wavelength of he-ne laser light is 633.75nm.

Percentage error is 0.15%.

PRECAUTIONS: 1) Never stare directly at the laser source, it may damage your eyes.

2) Before switching on the laser source, the system must be properly aligned.

3) Laser should neither be too close nor too far from the screen.

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COE(Section-3)