SYLLABUS

Any 6 Experiments

1. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
2. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
3. To find the polarization angle of laser light using polarizer and analyzer
4. V-I characteristics of LED
5. Thermal expansion of quartz using laser
6. Study the characteristics of solid state laser
7. Study the characteristics of LDR
8. Photovoltaic Cell
9. Characteristics of IR sensor

REFERENCE BOOKS

1. Advanced PRACTICAL Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics PRACTICAL s, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of PRACTICAL Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

WIDTH OF SLIT USING DIFFRACTION PATTERN BY A He-Ne LASER

Aim:

To determine the width of the slit using diffraction pattern by a He-Ne Laser.

Apparatus Required:

He-Ne laser, Double slit, Screen and meter scale

Formula:

The width of the slit is given by d = $\frac{\lambda D}{\beta}$ (m)

Where, β – fringe width (m)
d – Width of the slit (m)
D – Distance between the slit and cress (m)
λ - The wavelength of laser

Procedure:

- Place the double slit frame in front of the He-Ne laser at certain distances.
- Switch on the laser and gradually open the window of the double slit, so that the fringes can be viewed in the screen.
- Adjust the distance between screen and double slit to obtain clear and number of fringes.
- Record the fringes viewed in screen in the graph sheet for the number of fringes.

Tabulation:

Order of fringes	Distance between the fringes (mm)	Width of the three fringes (mm)	Fringe width
n n+1 n+2 n+9			

Result:

The width of the slit is ______ m.

SPECIFIC ROTATION OF SUGAR SOLUTION

Aim:
To determine the specific rotation of sugar solution by polarimeter.

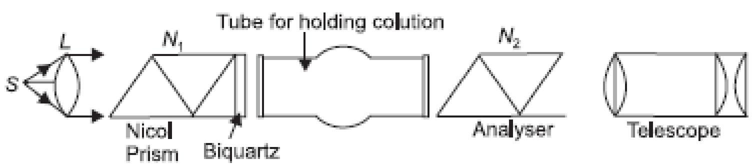
Apparatus Required:
Polarimeter, white light source, sugar, beakers, graduated jar, disc, weight box, balance.

Formula:
The specific rotation of the plane of polarization of sugar dissolved in water can be determined by the following formula.

$$S = \theta/lc = \theta v/lm$$

Where
q = rotation produced in degrees
l= length of the tube in decimeter
m = mass of sugar in gms dissolved in water
v = volume of sugar solution

Theory:
Polarimeter in general consists of a source of light a polarimeter and an analyzer provided with a graduated circular scale. Figure represents the general optical arrangement of most polarimeters.



S is a source of light, so placed that it is nearly at a focus of the lens *L* so that parallel pencil of rays enters the Nicol Prism N_1 which serves to polarize the beam of light passing through it. The polarizing nicol is immediately followed by a Laurent half shade plate or a biquartz. The other Nicol prism N_2 analyses the transmitted beam and detects its plane of polarization and is placed in front of a low power telescope. In between N_1 and N_2 is placed the tube *T* containing the liquid under investigation. The tube is closed on both sides with metal caps. When this tube is filled with solution containing an optically active substance, the air bubbles if any will appear at the upper side of the wide portion of the tube. The light from N_1 can pass through N_2 only if N_2 is placed in exactly the same way as N_1. In this case the Nicols are said to be parallel. If however, N_2 is turned from this position by a right angle no light from N_1 can pass through N_2. In this position the Nicols are said to be crossed. Certain substances like quartz, solution of sugar etc.possess the property of rotating the plane of polarized light. When it passes through them. On inserting the active substance on account of the rotation of plane of polarization, some light will pass through N_2 even when it is set in crossed position. It is found that rotation of N_2 in one direction or the other will again bring *N*2 into a plane in which light is once more stopped. Thus we can get the amount of rotation by measuring the angle through which N_2 has turned. Specific rotation is defined as the amount of rotation produced by one decimeter of the solution divided by the weight of the dissolved substance in unit volume. Let *W* grams be dissolved in 100 c.c. and suppose a length _ cm. of liquid produces a rotation θ.

$$[S]^D_t = \theta \Big/ \left(\frac{\ell}{10}\right) \div \left(\frac{W}{100} V\right)$$

$$= \left(\frac{10\theta}{\ell}\right) \div \left(\frac{W}{100}\right)$$

$$= 1000\,\theta / lw$$

Procedure:

1. Weigh sugar in a watch glass and dissolve the sugar in 100 c.c. Have distilled water.
2. Clean the polarimeter tube and fill it with distilled water. See that there is no air bubble in the tube when the end caps have been screwed.
Place the tube in its position inside the polarimeter.
3. Look through the analyser when it will be observed that two portions of the field of view of the sensitive biquartz device are of different colors red and blue.
4. Rotate the analyser till the two portions of the field of view are of same intensity or acquire tint of passage.
5. Take the reading of the analyzer on the circular scale. The settings of the analyzer should be done by rotating the analyzer in the clock-wise as well as by rotating in the anticlockwise directions.
6. Remove the distilled water from the tube and fill it completely with the sugar solution and again place it in the polarimeter. On looking through the analyzer the previous setting would be disturbed. Adjust the analyzer again till the two portions of the field of views acquire the gray tint shade. Take the reading of the analyzer.
7. Difference between the two settings of the analyzer (6) - (5) gives the value of the angle of rotation.
8. Repeat the experiment with sugar solution of different concentrations.
9. Measure the length of the tube _ and also note the room temperature.

Observation:

Room temperature = °C
Weight of the empty watch glass =
Weight of the watch glass + sugar =
Weight of the sugar employed =
Volume of the water taken =
Least count of the analyzer =
Length of the polarimeter tube =

Table for the Angle of Rotation: (1) For 1st solution.

Sl No.	*Position of analyzer with distilled water*				*Position of analyzer with sugar solution*				*Mean θ in degree*	*θ (in degree)*
	Clock wise rotation		*Anti clock wise rotation*		*Clock wise rotation*		*Anti clock wise rotation*		$\frac{1}{4}[(\theta_1-\theta'_1)+(\theta_2-\theta'_2)+(\theta_3-\theta'_3)+(\theta_4-\theta'_4)]$	
	One side vernier θ_1	*Other vernier* θ_2	*One side vernier* θ_3	*Other vernier* θ_4	*One side vernier* θ'_1	*Other vernier* θ'_2	*One side vernier* θ'_3	*Other vernier* θ'_4		
1.										
2.										
3.										

(2) *For 2nd Solution:* Same table as above

Result:
The specific rotation of sugar solution at = ______ degree.

REFRACTIVE INDEX OF A PRISM

Aim:
To determine the refractive index of a prism by using a spectrometer.

Apparatus Required:
Spectrometer, prism, mercury vapour lamp, spirit level and reading lens.

Formula:
The refractive index μ of the prism is given by the following formula:

$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

Where A = angle of the prism, δm = angle of minimum deviation.

Procedure:
The following initial adjustments of the spectrometer are made first.
- The spectrometer and the prism table are arranged in horizontal position by using the levelling screws.
- The telescope is turned towards a distant object to receive a clear and sharp image.

• The slit is illuminated by a mercury vapour lamp and the slit and the collimator are suitably adjusted to receive a narrow, vertical image of the slit.
• The telescope is turned to receive the direct ray, so that the vertical slit coincides with the vertical crosswire.

(A) Measurement of the angle of the prism:

• Determine the least count
• Place the prism on the prism table with its refracting angle A towards the collimator and with its refracting edge A at the centre. In this case some of the light falling on each face will be reflected and can be received with the help of the telescope.
• The telescope is moved to one side to receive the light reflected from the face AB and the cross wires are focused on the image of the slit. The readings of the two verniers are taken.
• The telescope is moved in other side to receive the light reflected from the face AC and again the cross wires are focused on the image of the slit. The readings of the two verniers are taken.
• The angle through which the telescope is moved; or the difference in the two positions gives twice of the refracting angle *A* of the prism. Therefore half of this angle gives the refracting angle of the prism.

(B) Measurement of the angle of minimum deviations:

• Place the prism so that its centre coincides with the centre of the prism table and light falls on one of the polished faces and emerges out of the other polished face, after refraction. In this position the spectrum of light is obtained.
• The spectrum is seen through the telescope and the telescope is adjusted for minimum deviation position for a particular colour (wavelength) in the following way: Set up telescope at a particular colour and rotate the prism table in one direction, of course the telescope should be moved in such a way to keep the spectral line in view. By doing so a position will come where a spectral line recede in opposite direction although the rotation of the table is continued in the same direction. The particular position where the spectral line begins to recede in opposite direction is the minimum deviation position for that colour. Note the readings of two verniers.
.• Remove the prism table and bring the telescope in the line of the collimator. See the slit directly through telescope and coincide the image of slit with vertical crosswire. Note the readings of the two verniers.
• The difference in minimum deviation position and direct position gives the angle of minimum deviation for that colour.
• The same procedure is repeated to obtain the angles of minimum deviation for the other Colours.

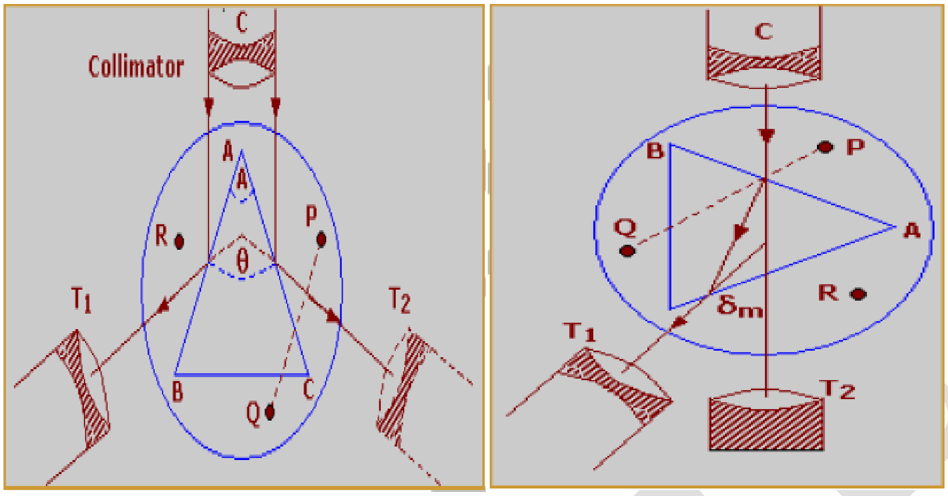


Figure: Left: Arrangement to determine the angle of prim.
Right: Arrangement to determine the angle of minimum deviation.

Observations:

(i) Value of the one division of the main scale = ……… degrees
Total number of vernier divisions = ………
Least count of the vernier = ……… degrees = ……… second

(ii) Table for the angle (A) of the prism.

S.No	Vernier	Telescope reading for reflection						Difference $\theta = a - b = 2A$	Mean value of 2A	A	Mean A degrees
		from first face			from second face						
		MSR	VSR	TR (a)	MSR	VSR	TR (b)				
1	V_1										
	V_2										
2	V_1										
	V_2										
3	V_1										
	V_2										

MSR = Main Scale Reading, VSR = Vernier Scale Reading, TR = MSR+VSR = Total Reading.

(iii) Table for the angle of minimum deviation (δm).

S.No	Colour	Vernier	Telescope reading for minimum deviation			Telescope reading for direct image			Difference $\delta_m = a - b$	Mean value of δ_m
			MSR	VSR	TR (a)	MSR	VSR	TR (b)		
1	Violet	V_1								
		V_2								
2	Yellow	V_1								
		V_2								
3	Red	V_1								
		V_2								

MSR = Main Scale Reading, VSR = Vernier Scale Reading, TR = MSR+VSR = Total Reading.

Calculations:
Angle of the prism = ………
Angle of minimum deviation for violet = ………..
Refractive index for violet = …………..
Angle of minimum deviation for blue = …………..
Refractive index for yellow = ………….
Angle of minimum deviation for red = ………..
Refractive index for red = …………..

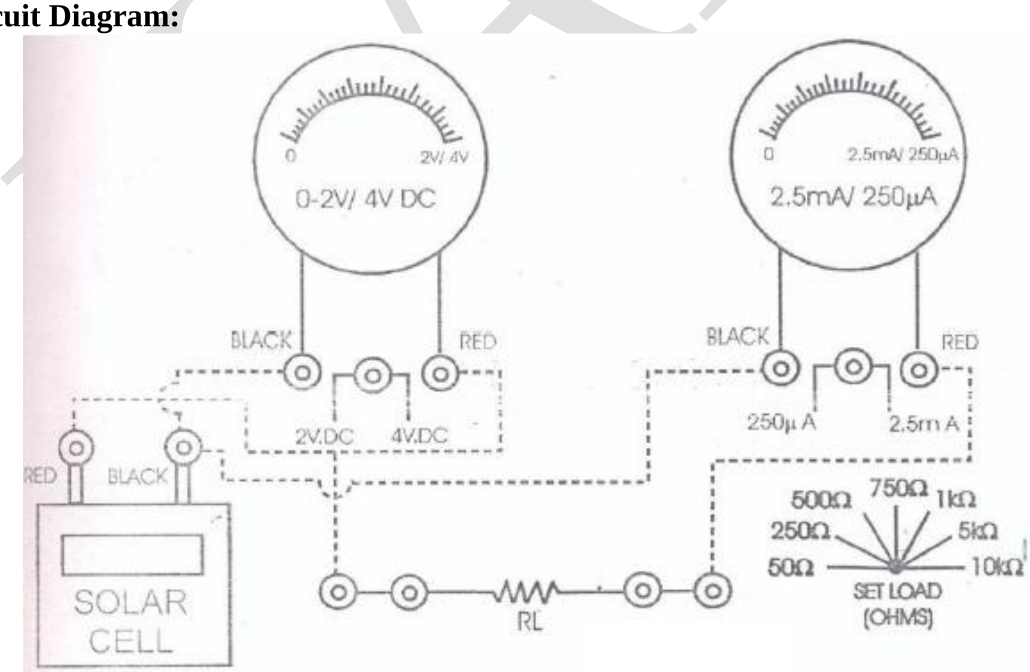
Result:
Refractive index for the material of the prism is =

V-I CHARACTERISTICS OF SOLAR CELL

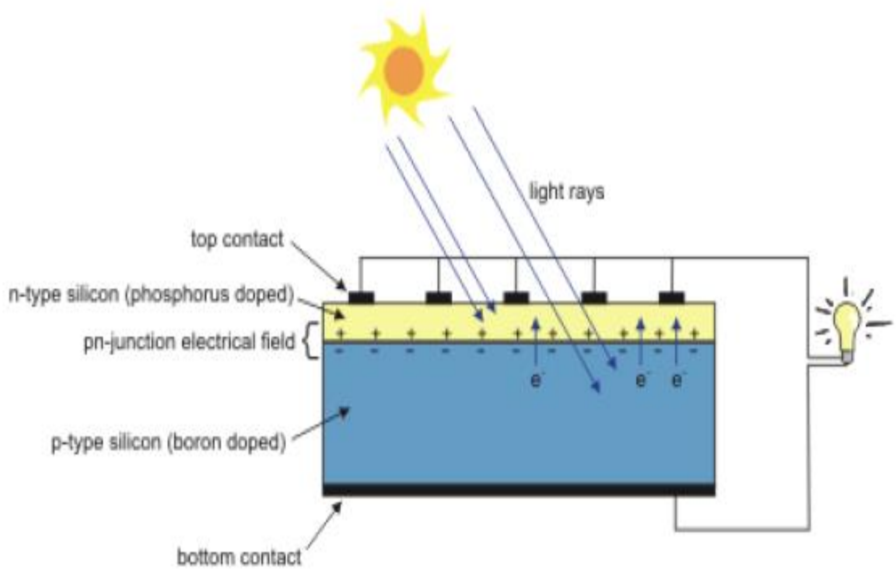
Aim:
To plot the V-I Characteristics of the solar cell.

Apparatus Required:
Solar cell apparatus, lamp, connecting wires

Circuit Diagram:



Theory:
The solar cell is a semi conductor device, which converts the solar energy into electrical energy. It is also called a photovoltaic cell. A solar panel consists of numbers of solar cells connected in series or parallel. The number of solar cell connected in a series generates the desired output voltage and connected in parallel generates the desired output current. The conversion of sunlight (Solar Energy) into electric energy takes place only when the light is falling on the cells of the solar panel. Therefore in most practical applications, the solar panels are used to charge the lead acid or Nickel-Cadmium batteries. In the sunlight, the solar panel charges the battery and also supplies the power to the load directly. When there is no sunlight, the charged battery supplies the required power to the load.

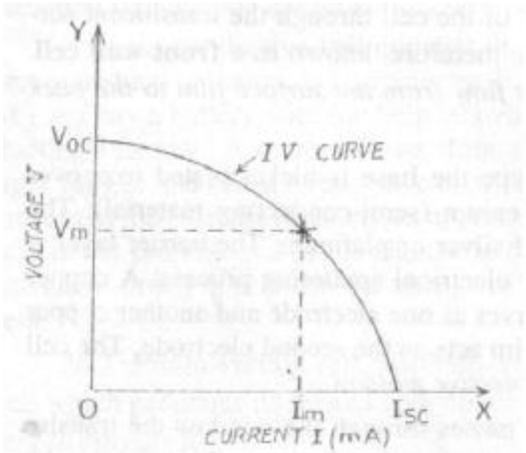


A solar cell operates in somewhat the same manner as other junction photo detectors. A built-in depletion region is generated in that without an applied reverse bias and photons of adequate energy create hole-electrons pairs. In the solar cell, as shown in Fig. 1a, the pair must diffuse a considerable distance to reach the narrow depletion region to be drawn out as useful current. Hence, there is higher probability of recombination. The current generated by separated pairs increases the depletion region voltage (Photovoltaic effect). When a load is connected across the cell, the potential causes the photocurrent to flow through the load.
The e.m.f. generated by the photo-voltaic cell in the open circuit, i.e. when no current is drawn from it is denoted by VOC (V-open circuit). This is the maximum value of e.m.f.. When a high resistance is introduced in the external circuit a small current flows through it and the voltage decreases. The voltage goes on falling and the current goes on increasing as the resistance in the external circuit is reduced. When the resistance is reduced to zero the current rises to its maximum value known as saturation current and is denoted as ISC, the voltage becomes zero. A V-I characteristic of a photo-voltaic cell is shown in Fig.
The product of open circuit voltage V_{OC} and short circuit current I_{SC} is known a ideal power.

$$\text{Ideal Power} = V_{OC} \times I_{SC}$$

The maximum useful power is the area of the largest rectangle that can be formed under the V-I curve. If Vm and Im are the values of voltage and current under this condition, then
Maximum useful power = Vm × Im
The ratio of the maximum useful power to ideal power is called the fill factor
Fill factor = Vm × Im / $V_{OC} \times I_{SC}$

Model Graph:



Procedure:
1. Place the solar cell and the light source (100 watt lamp) opposite to each other on a wooden plank. Connect the circuit as shown by dotted lines (Fig. 2) through patch chords.
2. Select the voltmeter range to 2V, current meter range to 250μA and load resistance (RL) to 50Ω.
3. Switch ON the lamp to expose the light on Solar Cell.
4. Set the distance between solar cell and lamp in such a way that current meter shows 250 μA deflections. Note down the observation of voltage and current in Table 1.
5. Vary the load resistance through band switch and note down the current and voltage readings every time in Table 1.
6. Plot a graph between output voltage vs. output current by taking voltage along X-axis and current along Y-axis.

Observations:

S.No	Voltage	Current	Load Resistance

Result:
V-I Characteristics of the solar cell has been plotted.

CHARACTERISTICS OF LED

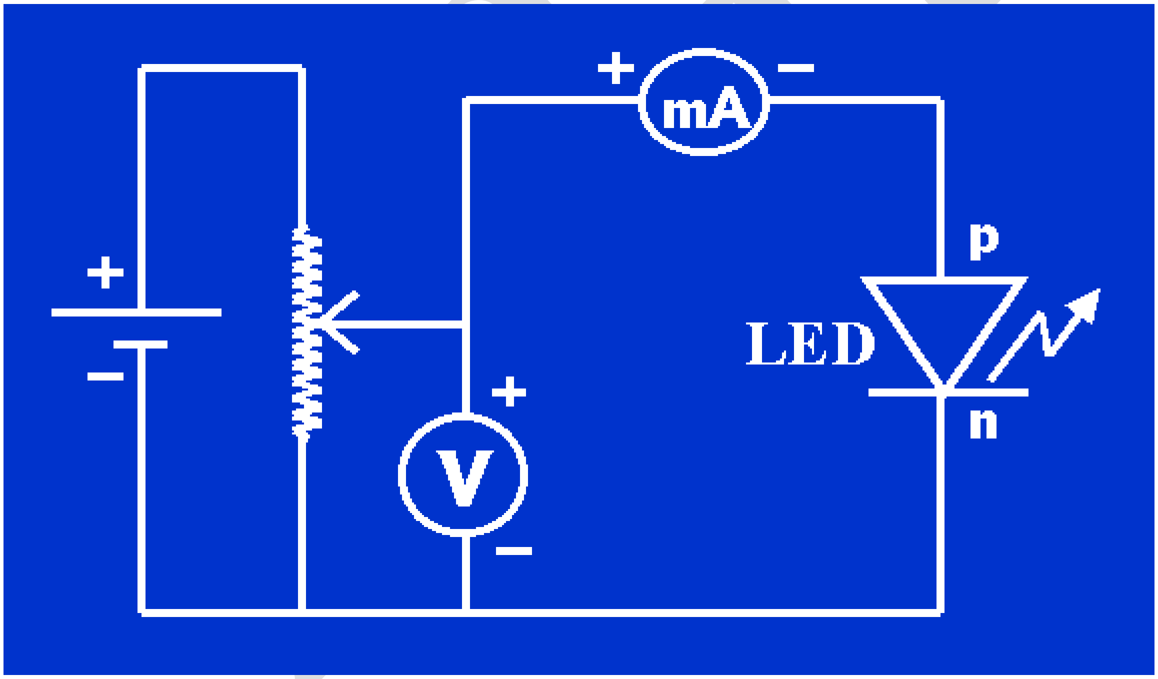
Aim:

To study of characteristics of light emitting diode (LED).

Apparatus Required :

LED, Ammeter (0-50 mA), Voltmeter (0-10 V), DC power supply, Rheostat

Circuit Diagram:



Procedure:

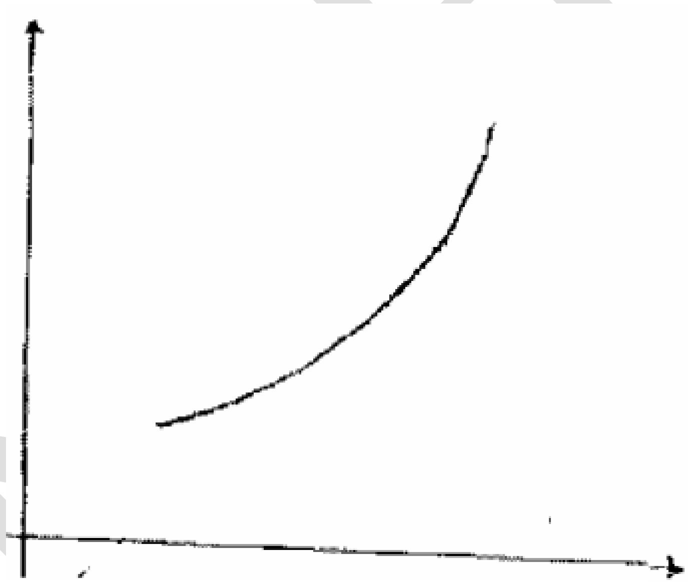
Make the connections as shown in circuit diagram. Switch on the power supply. The voltage is set at 0 V and the current through the LED shown by milliammeter is recorded. With the help of slider of rheostat, the voltage is increased in steps of 0.2 V. For each setting of the voltage, corresponding current shown by the microammeter is noted. The observatuions are recorded in table.

Observations:

Voltage	Current

Model Graph:

The graph is plotted, by taking forward voltage on the positive x axis and forward current on the positive y axis.



Result:
The characteristics of light emitting diode has been plotted.

WAVELENGTH OF LASER USING DIFFRACTION GRATING

Aim:

To find a wavelength of laser source using diffraction grating.

Apparatus required:

Diffraction grating, Laser source, Large screen, Stand with grating mount, metre scale

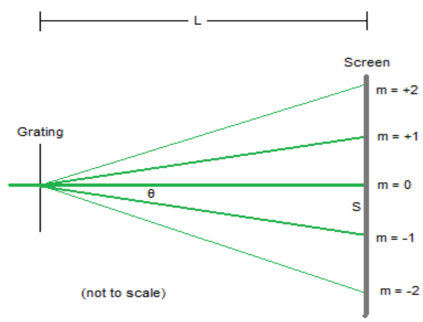
Principle:

When light passed through a diffraction grating the transmitted light gets diffracted. From the theory of diffraction grating at the normal incidence, the diffracted ray satisfy the equation

$$\text{Sin } \theta_n = Nn\lambda$$

Where θ_n is the angle of diffraction for the order n = 1,2,3…etc. λ is the wavelength of the laser and N is the number of lines per metre on the grating. If x_n is the distance of the n th order from the central spot on the screen and d is the distance between the grating and the screen, then

$$\text{Sin } \theta_n = x_n / \sqrt{Xn2 + d2}$$



Procedure:

Laser, grating and a screen are arranged in a line as shown in a figure. Switch on the laser and pass through the grating so that the diffraction pattern can be seen on screen. The pattern consists of bright diffraction bands of orders n = 1,2…etc. On either side of the central spot. For normal incidence, the grating is aligned such that the separation between the central spot to the first order spot on both sides are equal. Adjust the spacing between the grating and the screen d to 0.23 m. Find the distance to the n th order (n=1,2) diffracted spot from the central spot on both sides of it on the screen as x_n. From the mean value of x_n, calculate $\text{Sin } \theta_n = x_n / \sqrt{Xn2 + d2}$ for each order. The number of lines per metre of the grating N is also noted. Then the wavelength given by $\lambda = \text{Sin } \theta_n / Nn$ is calculated. The experiment is repeated for various distances d= 0.5,0.75 and 1 m and the mean value of wave length is calculated.

Table :

Number of lines per metre on the grating N = ______ lines / m

s.no	Order n	Distance to the diffracted spot from the central spot x_n (m)			$\sin\theta_n = x_n/\sqrt{X_n^2 + d^2}$	Mean $\sin\theta_n$	$\lambda = \sin\theta_n / Nn$ (m)
		Left	Right	Mean			
1 2 3	I						
1 2 3	II						

Result :

Wavelength of the laser light = ________ m.