National Anveshika Experimental Skill Test -2021

(NAEST – 2021)

Name:..Class...................................

Roll NO.................................Mobile No...

School/College Name...

Date..Time...

F1- To find the wavelengths of light from red and blue LEDs.

Background

Light emitting diodes are widely used in domestic lighting applications. The basic colours available are red, green and blue. In this experiment you will obtain the average wavelength for light from a red and a blue LED provided.

Diffraction Grating

The key element in this experiment is Diffraction grating. On a glass plate, very close parallel lines are carved to make these portions opaque. The glass between two such lines acts like a slit. Gratings typically have several thousand lines per inch of the width. The slit separation d is inverse of lines per unit length.

If a parallel beam of light of wavelength λ is made to fall on the grating normally, it splits into several beams on the other side.

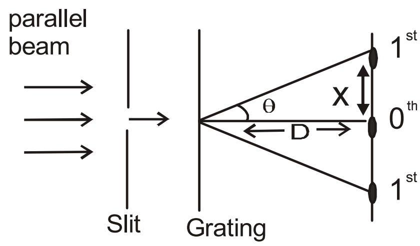

Figure-1

The one going in original direction is called 0^{th} order line, the next beams on the two sides are called 1^{st} order, then 2^{nd} order and so on. The angle at which the m^{th} order beam appears is given by $d\sin\theta = m\lambda$. Where d is the slit separation. For 1^{st} order

$$d\sin\theta = \lambda$$

Materials

A plane diffraction grating, LEDs (red, blue), a green laser (wavelength = 532 nm), lens/laser stand, slit, 5 V power supply, long heater coil, a jockey, connecting wires, an wooden base bench with a wide screen attached to it, a multimeter, a mica sheet, a black screen with a narrow slit, a pencil and a convex lens.

(**Note:** Check all the given materials before use)

Experiment

The base bench has four screws at the corners. Use them to ensure that the bench stays on the floor in stable situation. The laser stand also has a screw at the top.

Use this screw to adjust the fine orientation of the laser torch so that the laser falls at the desired position.

Part-A : Get the slit separation and hence number of lines per inch

Set up the green laser at its stand horizontally on the base bench and let the light fall on the screen. This laser has a wavelength of 532 nm. Put the grating perpendicular to the laser beam. You should get several spots on the screen.

Identify the central spot and the two first order spots as suggested in Figure 1. Measure the distance D between the grating and the screen. Measure the separation between the central and the 1^{st} order spots on the two sides. You can mark the spots on the screen for better measurement. Remove the laser and grating and then measure the distances comfortably. From the geometry, find $\sin\theta$ for diffraction of 1^{st} order. Using

$$d \sin\theta = m\lambda$$

find d and hence lines per inch N. Do the same for 2^{nd} order spots. Compare with that written on the grating. You can change the separation between the grating and the screen and repeat the exercise.
Write the data in a neat tabular form.

Part-B: To get a parallel beam from LED.

Set up the Red LED on the base bench. Find the + and – terminals on the LED stand. You are given a power supply and a long heater coil to be used as a potential divider as shown in Figure-2. Using the multimeter, find the higher potential side and lower potential side on the heater coil. Properly connect the LED. Apply voltage to light the LED with a good glow. Avoid increasing voltage too much after the good glow. LEDs get damaged for voltages>3 volts. LED gives a diverging beam. Use a convex lens to get a parallel beam. To do this, you should keep the LED bulb at the focus of the lens.

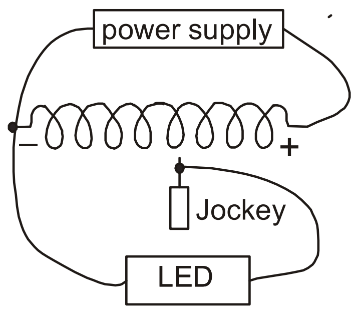

Figure-2

Find the approximate focal length of the lens by making the image of distant objects on the screen. Place the lens at this distance from the LED and let the light fall on the screen. You will see the bright disc of light coming from the lens. Measure its diameter D1. Now place the given mica sheet close to the lens and measure the diameter D2 of the bright disc formed. If the light coming from the lens is a parallel beam, D1 and D2 must be the same. Make finer adjustment to achieve this.

Part-C: Get the diffraction patterns from the LEDs and calculate the wavelengths.

Fix the black screen with a slit in the path of the parallel LED beam. Put the grating in front of the slit so that the

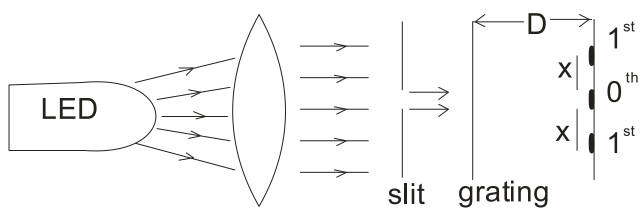

Figure-3

beam passing through the slit falls on the grating. Collect the light on the other side, on the white screen attached to the bench. You should see a bright central rectangular spot (0^{th} order) and two side spots (1^{st} order) with faint intensity. You may have to put off the room lights to see these spots clearly and mark them. Mark the position of the 0^{th} and 1^{st} order spots. Measure the distance D between the grating and the screen. Measure the separation x between the 0^{th} and 1^{st} order spots. By changing the distance between the grating and the screen, repeat the measurement for at least two times.

Using the value of d calculated in Part-A, calculate the wavelength of the LED light. Do it for both the LEDs given.

Estimate of Errors/Extensions/Comments