LU5: LAB 1-5B.1: Interference and Diffraction: Single Slit

REFERENCES:

- *Fundamentals of Light & Lasers* (OPTEC), 2nd edition
- Module 5, Laboratory 1-5B.1, pages 48-49.
- http://optecvideo.opteccrm.org, Video 18: Read these instructions and watch the videos before doing the lab.
  - Course 1: Fundamentals of Light and Lasers
  - Lab Activity Video
  - Choose Video #

THEORY:

A single slit produces a diffraction pattern. Monochromatic light bends (diffracts) as it passes through the slit. A pattern of light & dark fringes are created as wave phases of the same wave interact

OBJECTIVE:

Create a diffraction pattern with a single slit.
Use measurement from the fringe patterns to determine the single slit width.
To do a comprehensive and precise Lab Write-up.
Take appropriate pictures (5 or more) to prove/show lab work.

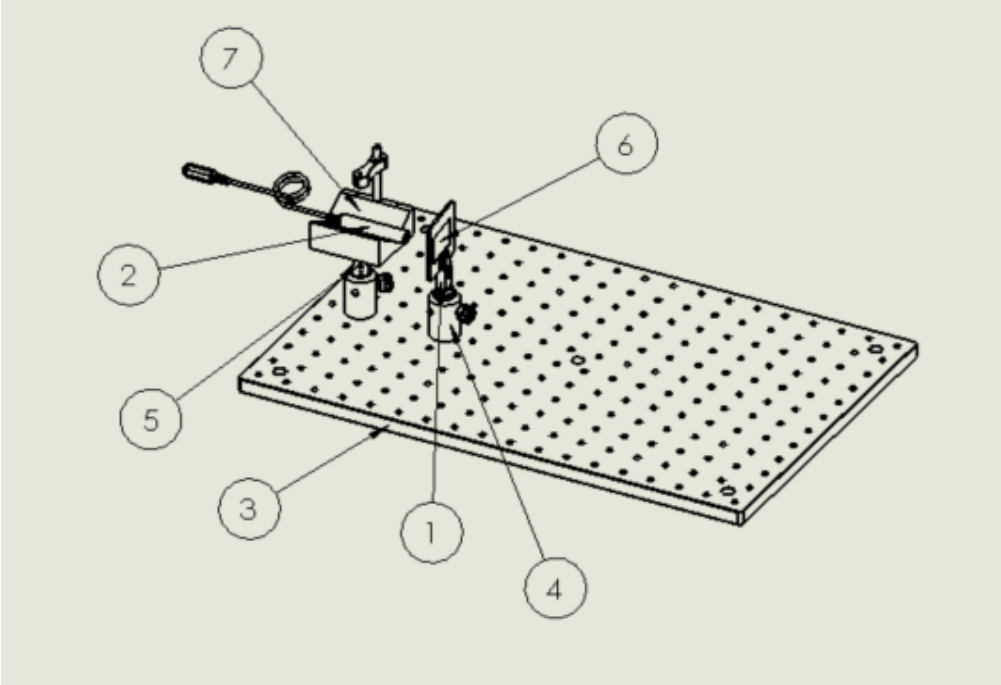
EQUATIONS:

$y_m = (m\lambda D)/b$ therefore: $b = (m\lambda D)/y_m$

y_m = distance from central fringe to dark fringe with order number $m_{1,2,3.....}$
λ = wavelength of incident light; actual λ for Laser Diode
m = order number of dark fringe from the central bright fringe
D = distance from the slit to the screen; D >> b (D must be much greater b)
b = slit width

EQUIPMENT:

Fixed Lens Mount (key 1)
Laser Diode Module (key 2)
Laser Diode Power Supply
Optical Breadboard (key 3)
(2) Post Holder (key 4)
(2) Post (key 5)
100µm Slit, Mounted (key 6)
V-Clamp (key 7)



SET-UP: Read the entire SET-UP and PROCEDURE before starting the lab.

1. Mount a post holder in the first hole at the left end of the breadboard.
2. Assemble a post to the center hole on the bottom of the V-clamp and insert the assembly into the post holder.
3. Attach the fixed lens mount to a post and insert the assembly into a post holder. Don't mount to the board.
4. Place the vertically oriented single slit into the fixed lens mount. Set in proposed beam path.
   a. Create an index card (screen) assembly (post holder, post, filter holder). Place at last hole positon opposite the laser output. This is to mark horizontally oriented fringe positions.
5. Mount the laser diode and position the beam path along the length of the board and on to the screen.
   a. Remember to align beam to center of a row of holes.

PROCEDURE: Read this complete procedure before following it

NOTE: Beginning with this lab and all subsequent labs, each measurement will be done three (3) times and recorded and the recorded average will be used in calculations.

1. Turn on laser.
2. Position the slit in front of and very close to beam output.
    a. Make adjustments to slit so that the laser beam is centered on it and a clear diffraction pattern is formed on the screen.

    b. The screen assembly may need to be moved closer.
    c. The darker the environment, the better.
    d. Attach slit assembly to optical plate.
3. **Measure 3 times and average and record** the distance, D, from the slit to the screen. Positioning the screen to have a measurement ending in a zero will simplify calculations.

    D = _____

4. **Accurately mark** the center of the central bright fringe of the pattern and the midpoint of the first four **DARK** fringes on either side of the central bright fringe (dim the room lights to make the pattern more visible).
5. Remove the paper from the screen and **measure three times and average** the distance, y_m , from the central bright fringe to each of the **DARK** fringes. **Enter** the values in the table like the one below next to the appropriate fringe order number, m (number of fringe from the central fringe).

Single Slit		
Dark fringe distance, y_m	Order, m	Slit width, b
	1	
	2	
	3	
	4	
-	-1	
-	-2	
-	-3	
-	-4	
Average Slit Width		

CALCULATIONS:

1. Use **$b = (m\lambda D)/y_m$** to calculate and record the width of the single slit for each fringe measurement. Use the given λ of the red light laser and the screen distance, D, from Step 3 of the Procedure.
2. **Calculate and record** the average slit width and enter the result in the table above.
3. **Calculate and record** the average of the entries in the Slit Width column and enter the value in the table.

ANALYSIS:

1. A method of research in which a problem is identified and observations, experiments or other relevant data are gathered, a hypothesis is formulated, and is empirically tested.
    a. Hypothesis: a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.
2. Identify the problem (objective) to solve or accomplish.
    a. THINK: hypothesize a possible outcome; include in objective.
3. Use the lab to complete the objective and test your hypothesis.
4. Perform the experiment(s).
    a. Gather the data.
5. Analyzed the results of the process.
    a. An examination of data and facts to uncover and understand the cause/effect relationships.
    b. Accept, reject, or modify the hypothesis.
    c. Explain your reasoning.