VE438: Advanced Lasers and Optics Laboratory

Laboratory manual
Lab 1: Polarization, Total Internal Reflection and Single Slit Diffraction[1]

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1 Suggested Reading Assignment

Optics (Hecht) Ch 2, 4, 8, 10

2 Pre-lab Questions

1. What is "Total Internal Reflection (TIR)"? Calculate the angle of TIR between water and air.
2. What is Brewster's angle? Calculate the Brewster's angle for water/air interface.
3. Find the minimum thickness for (a) a quarter-wave plate (b) a half-wave plate. ($n_o = 1.5443, n_e = 1.5534$)
4. Explain the difference between Fraunhofer diffraction and Fresnel diffraction.
5. How to block one linear-polarized laser beam with two polarizers? With the same setup, how to allow the laser beam to pass through using a half-wave plate?

3 Procedure

NOTICE:

- Pay attention to all lab safety instructions. Lasers used in the lab might hurt your eyes if you look into the beam directly.
- Equipment used in optics experiments such as mirrors and prisms are very fragile thus special operating rules need to be followed. Your grade for in-lab operation will be deducted for improper operations.
- Make sure the checklist below is clear before leaving the lab:
  - ☐ The experimental setup has been shown to the TA;
  - ☐ The data sheet has been checked and signed by the TA;
  - ☐ The equipment has been restored;
- TA will give a question to one of the group members to check your understanding on lab content. Grade for in-lab operation and the question will be shared among the whole group.

PART A: Polarization

1. Put a polarizer on the mount and let the laser pass through the center of the polarizer.
2. Use the photon diode to measure the intensity of the transmitted light.
3. Rotate the polarizer to approach the maximum transmission intensity. Record the position as the zero point.
4. Rotate the polarizer and write down the intensity (in voltage) every 5 degrees. 36 data points are required.

PART B: Total Internal Reflection

1. Put the prism onto the rotation stage. Make sure the hypotenuse side of the prism pass through the center of the rotation stage.
2. Rotate the prism and find the critical angle for Total Internal Reflection.
3. Record the incident angle and calculate the refractive index of the the prism (glass).

PART C: Diffraction

1. Mount the single slit and let laser beam pass through the slit.
2. Adjust the width of the slit until apparent diffraction pattern is observed.
3. Measure the distance between the slit and the screen.
4. Measure the distance between the $+1, 0, -1$ order diffraction pattern.
5. Estimate the width of the slit with the data you obtained.

4 Post-lab Questions

1. Describe your observation in PART A when the laser beam pass trough a polarizer. What happened when you rotate the polarizer? Can the laser beam be totally blocked? Explain your answer with Malus' Law.
2. Compute the refractive index of the prism with the critical TIR angle you obtained in PART B. Plot your experiment scheme. Calculate the amplitude transmission coefficient out of the prism. (Notice that the laser beam hits 3 interfaces between air and glass)
3. Compute the width of the aperture with the diffraction pattern you observed in PART C.