PH 481 **Physical Optics** **Winter 2020**

Laboratory #7 **Week of February 24**

Read: pp. 330-339, 408-416 of "Optics" by Hecht
Do:
1. Experiment VII.1: Law of Malus
2. Experiment VII.2: Interference in a microscope slide
3. Experiment VII.3: Absorption of Materials

Experiment VII.1: Law of Malus

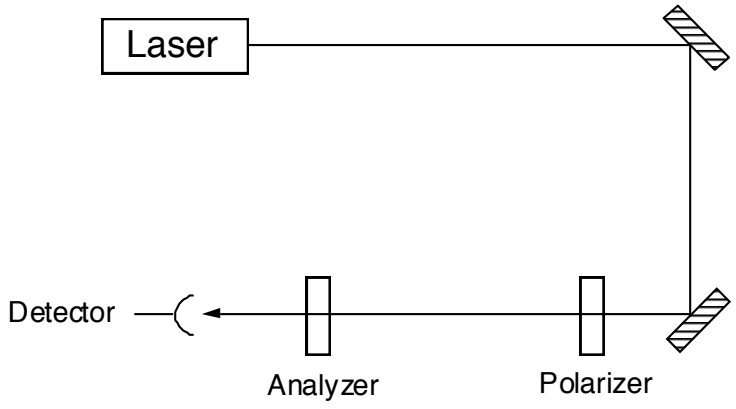
The goal here is to verify the Law of Malus (Hecht, p. 338, Eq. 8.24). This law describes how the intensity of light transmitted through a linear polarizer varies as a function of the angle θ between the polarizer transmission axis and the plane of polarization of the incident light. Malus's Law is

$$I(\theta) = I(0)\cos^2(\theta),$$

where $I(0)$ is the transmitted intensity when the polarizer transmission axis and the plane of polarization of the incident light are parallel.

To verify Malus's Law, you will use two polarizing sheets and a photodetector as shown in the figure (see also Hecht p. 338). By convention, we will call the first polarizing sheet the Polarizer and the second the Analyzer. The Polarizer ensures that the light reaching the Analyzer is linearly polarized. Since the laser is already linearly polarized, the Polarizer can also be used to adjust the amount of laser light used in the experiment so that the photodetector is not saturated. In practice, you want to make sure that the maximum signal you measure from the photodetector is no more than the half the battery bias voltage (12V).

Only one of the polarizing sheets is mounted in a rotation mount; use that one as the Analyzer. The Polarizer can simply be held in a filter holder. Measure the power transmitted through the Analyzer as a function of the rotation angle of the Analyzer. Measurements at 5˚ or 10˚ intervals should be sufficient, except near θ = 0˚ and θ = 90˚ where more points will be needed. It is useful to first find the minimum and maximum points and eliminate noise, so that $I(0)$ can be properly determined. Plot your results and compare them with the theory.



Experiment VII.2: Interference in a microscope slide

1) Position a clean microscope slide in the path of the expanded laser beam. Observe the interference pattern in reflection as a function of angle of incidence. Explain what happens.
2) Now measure the angles at which adjacent minima occur and use Hecht Eq. 9.37 to determine the thickness of the slide.
3) Repeat the same procedure with a cover slip. How is the interference pattern different from that with the microscope slide? Observe the interference pattern in transmission. Why is the contrast so much lower compared to that in reflection?
4) Heat the slide with the hot air gun or the soldering iron – what happens? Explain.

Equipment needed:

Item	Qty	Source (part #)
Helium-Neon Laser	1	Melles Griot 05 LHP 121
Al mirror	3	Newport 10D10ER.1
Polarizer	2	Edmund A38,396
Microscope cover slip	1	Edmund A40,002
Rotation Mount	1	Thor Labs RSP1
Filter holder	1	Thor Labs DH1
Photodetector	1	Thor Labs DET1-SI
Voltmeter	1	Fluke 75
Hot gun or soldering iron	1	