110B Homework 6

1. (20 points) Design an antireflection coating for a piece of glass. Because human eyes are most sensitive to green light, we want to have antireflection coating at 530 nm. This can be achieved by depositing a thin layer of material with refractive index between air and glass on top of the glass. What is the thickness and refractive index of the thin film for minimum reflection (therefore highest transparency)? As a simplification, neglect multiple reflections and consider normal incidence.

2. (20 points) We have a thin wedge (i.e. it has two flat surfaces with a small angle between them) composed of an unknown material. Use a He-Ne laser at 632 nm and optical interference to determine the angle of the wedge and refractive index of the material at 632 nm.

3. (15 points) Silicon wafer with a thin layer of SiO2 is widely used in semiconductor industry for fabricating integrated circuits. One easy way for accurate determination of the SiO2 layer thickness is from the color of the silicon wafer. Si and SiO2 have refractive indices of 3.2 and 1.5, respectively. What is the reflection color we should see for silicon with 310, 345, and 390 nm thick SiO2 for normal incidence?

4. (15 points) If one of the mirrors of the Michelson interferometer is misaligned by a small angle δ, describe how the interference pattern will change in the detector plane when the distances between the beamsplitter to the two mirror centers are the same. What will happen to the pattern if one mirror moves?

5. (30 points) Plot the light intensity as a function of Michelson mirror position for incident light with the following spectrum. Consider only forward direction with $\theta=0$), and plot the range x=-20 to 20 μm.

(a) I(k)=1, for 550nm $<\lambda<$650nm, I(k)=0 for other wavelengths.
(b) I(k)=1, for 590nm $<\lambda<$610nm, I(k)=0 for other wavelengths.
(c) I(k)=1, for 550nm $<\lambda<$590nm and for 610nm $<\lambda<$650nm, I(k)=0 for other wavelengths.
(d) Compare the results in a, b, c. Can you explain their behavior qualitatively?