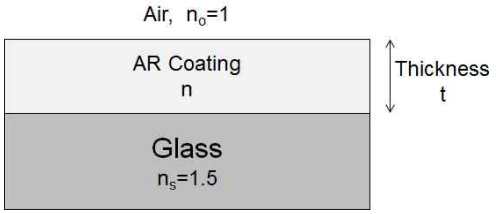
Optoelectronics EE 430.423.001 Midterm Exam 2 2016. 11. 8.

1. (10 point) Determine the refractive index n and thickness t to be deposited on a glass substrate (n_s=1.5) such that the coating is highly antireflective (AR) for the center of the white light spectrum, *i.e.*, at λ_o=550 nm.



2. (25 point) Consider the irradiance at P when a monochromatic light from a point source S is obstructed by a opaque screen with a circular hole of radius R, perpendicular to $\overline{SP}$ with its center on this line. The distance from the center of the hole to the source S and the detection point P is L_s and L_p, respectively. Answer the following questions using the Fresnel diffraction theory.

(1) Explain how the irradiance at P changes as the radius of the hole R increases.

(2) Find the radius $R_{\max}$ of the hole for the first maximum.

(3) Find the radius $R_{\min}$ of the hole for the first minimum.

(4) Find the ratio of the irradiance for $R=R_{\max}$ to the irradiance for $R=\infty$.

(5) What is the irradiance at P when the screen with a circular opening is replaced with an opaque circular disk of radius $R_{\max}$ (Hint. Use the Babinet's principle for the simplicity).

3. (15 point) Suppose that coherent laser light from a HeNe laser (λ = 632.8 nm) is incident on a single slit of width b=0.2 mm. The observation screen is L=2.0 m from the slit.

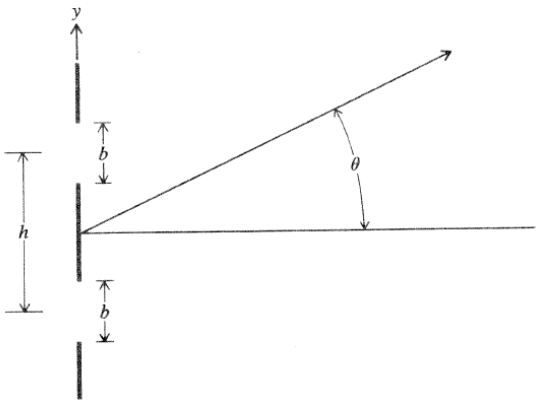
(1) What is the width of the central bright fringe?

(2) How much does the width of the central bright fringe change when the slit width is reduced by half?.

(3) What is the width of the bright fringe between the (m+1)-th and m-th minima, where m>1?

4. (20 point)

Consider a diffracting aperture of two parallel slits, each of width b and separated by a distance h.



(1) Calculate the irradiance distribution of the Fraunhoffer diffraction pattern by a double-slit aperture.

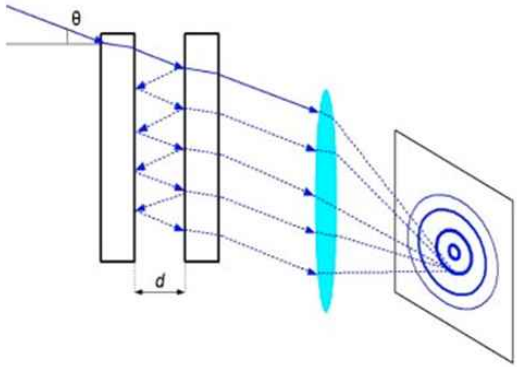
(Hint. The amplitude of the Fraunhoffer diffraction pattern is given by

$$U = C\iint_{aperture} e^{ikr}dA.)$$

(2) Plot the irradiance distribution for case of h=3b. If h=mb, where m is any number, how many bright fringes (counting the fractional fringes as well) are within the central diffraction peak?

5. (30 point)

(1) Calculate the transmitted intensity for the light passing through the Fabry-Feort etalon consisting of two identical semireflecting mirrors separated by the gap d. The reflectance and transmittance of the mirror is R and T, respectively.



(2) Find the condition for the fringe maximum.

(3) Calculate the resolving power $RP = \frac{\omega}{\delta\omega} = \frac{\lambda}{|\delta\lambda|}$.