Physics 234
Homework 5 (Due Wednesday, February 17)
Interference Effects

Due to the exam being on Friday, only **your best 4 of the 7 problems will be graded. You only need to solve 4 problems.**

Problem 1.
Young's double slit experiment is performed with blue-green light of wavelength 500 nm. The slits are 1.2 mm apart and the screen is 5.4 m from the slits. How far apart are the bright fringes?

Problem 2.
A lens is coated with a thin transparent film to minimize reflection of the red component of white light. The index of refraction of the film is 1.30 and that of the lens is 1.65. What minimum thiskness of film is needed? The wavelength of the light in air is 680 nm.

Problem 3.
A broad source of light ($\lambda = 680\ nm$) illuminates normally two glass plates 120 mm long that touch at one end and are separated by a wire 0.048 mm in diameter at the other end. See the figure. How many bright fringes appear over the 120 mm distance?

Problem 4.
An airtight chamber 5.0 cm long with glass windows is placed in one arm of the Michelson interferometer as indicated in the figure. Light of wavelength $\lambda = 500\ nm$ is used. The air is slowly evacuated from the chamber using a vacuum pump. While the air is being removed, 60 fringes are observed to pass through the view. From these data, find the index of refraction of the air that was in the chamber.

Problem 5.
A slit 1.0 mm wide is illuminated by light of wavelength $\lambda = 589\ nm$. We see a diffraction pattern on a screen 3.0 m away. What is the distance between the first two diffraction minima on the same side of the central diffraction maximum?

Problem 6.
Derive the following expression for the intensity pattern for a three slit "grating":

$$I = \frac{1}{9} I_0 (1 + 4cos(\phi) + 4cos^2(\phi)) \tag{1}$$

where

$$\phi = \frac{2\pi d \; sin(\theta)}{\lambda} \tag{2}$$

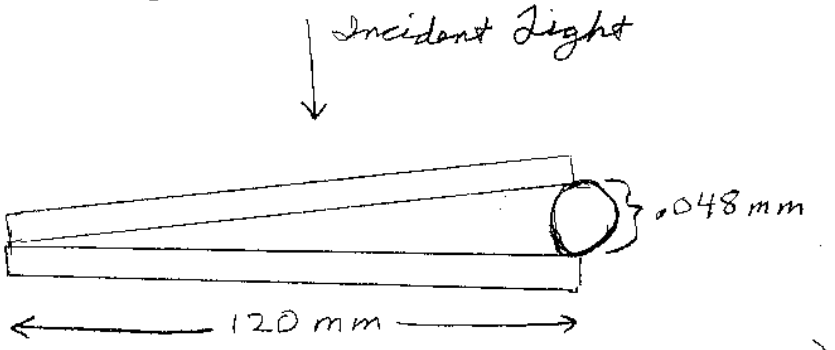
Assume that $d << \lambda$.

Problem 7.
Assume that the limits of the visible spectrum are chosen as 430 and 680 nm. Calculate the number of rulings per mm of a grating that will spread the first-order spectrum through an angular range of 20°.

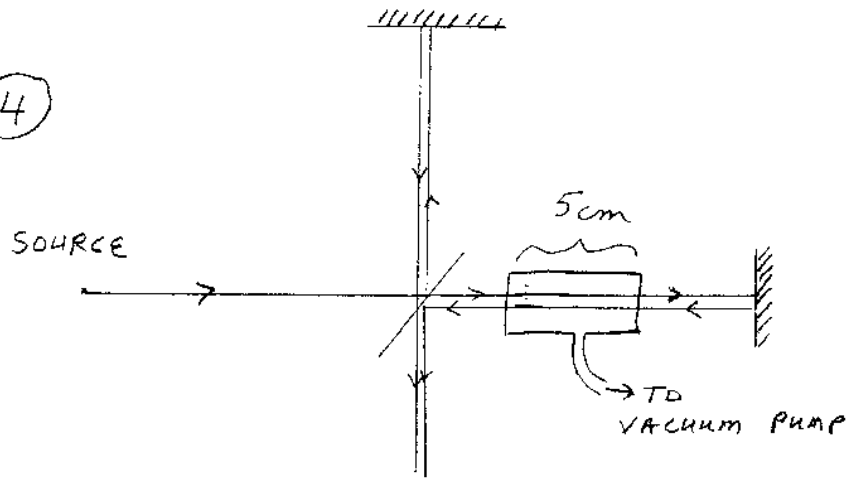
See the next page for the figures

Figures

(3)


Incident Light
.048 mm
120 mm
(NOT DRAWN TO SCALE)

(4)


SOURCE
5cm
TO
VACUUM PUMP