PHYSICS 2P51: Assignment 9/10 - Due Wed. March 29, 2017

1. **Michelson interferometer**

   (a) Consider a Michelson interferometer using a source of 632.8 nm light. What is the displacement of the moving mirror if 2500 fringes cross the center of the interference pattern?

   (b) If one arm of a Michelson interferometer contains a tube 3.5 cm long that is first evacuated and then slowly filled with air ($n = 1.0003$), how many fringes will cross the centre? Assume light of 600 nm wavelength.

   (c) Consider a Michelson interferometer that contains an imperfect beamsplitter which creates two interfering beams at the detector with unequal intensity: 0.5 mW/m^2 and 0.4 mW/m^2. Assume a monochromatic source of wavelength 550 nm. Determine the intensity at the detector as a function of moving mirror position x. What are the maximum and minimum intensities measured?

2. **Thin Film Inteference**

   (a) A soap bubble ($n = 1.4$) has a wall that is 0.36 μm thick. If seen at normal incidence in reflected white light, what colour is it?

   (b) What percentage of incident light is reflected at the surface of a glass of index n=5/3? If one wanted to minimize the reflectance at $\lambda = 550nm$, what is the minimum thickness of MgF_2 ($n = 1.38$) that must be deposited on the surface of the glass?

   (c) A wedge-shaped spaced between plane glass plates if filled with water ($n = 4/3$) in such a way that there a few bubbles of air are trapped between the plates. If 18 fringes are counted with a given distance inside an air bubble, how many fringes, within the same distance, are seen in water?

3. **Single slit Diffraction**

   (a) How many wavelengths wide must a single slit be if the first Fraunhofer diffraction minimum occurs at an angular distance of 30° from the optical axis.

(b) A slit 0.14 mm wide is illuminated by monochromatic light. If on a screen 2m away from the slit, the two second-order minima are 3 cm apart from each other, what is the wavelength of the light?

4. **Real Double Slit** Recall that the intensity for two slits of width a separated by distance d varies as

$$I = I_o(\frac{\sin\alpha}{\alpha})^2 \cos^2(\beta)$$

where $\alpha = \pi\frac{a\sin\theta}{\lambda}$ and $\beta = \pi\frac{d\sin\theta}{\lambda}$. That is, it is a superposition of the single slit pattern and the equally spaced double slit fringes. Determine how many double slit maxima lie within the wide central single slit fringe.