

Homework 5 - Interference**P. Herman**

- 1 (a) Twenty fringes were counted on a Michelson Interferometer while moving one of the mirrors a 10 micron distance. What is the source wavelength?

Ans. wavelength = 1 micron

- (b) How many rings are visible on a Michelson Interferometer with a source divergence of $\pm 2^\circ$ and mirror separation of $d = 0$? $d = 3$ microns? $d = 2$ mm?
 Ans. one dark fringe; $\Delta m = 5.5$ fringes; $\Delta m = 3997$ fringes

2. A pinhole of 0.5 mm diameter is used as a source for a Young double-slit interference experiment. A sodium lamp ($\lambda = 590$ nm) is used. If the distance from the source to the double-slit aperture is 0.5 m, what is the maximum slit spacing such that interference fringes are just observable?

Ans. 0.59 mm

3. What is the line width in hertz and in nanometers of the light from a helium-neon laser whose coherence length is 5 km? The wavelength is 633 nm.

Ans. 8.01×10^{-8} nm, 60,000 Hz

4. Accurately determine the normal incidence reflectance of a quarter wave anti-reflection film of magnesium fluoride ($n_m = 1.35$) coated onto the surface of optical glass with index $n_g = 1.52$. (Work out the problem from first principles summing multireflections.)

Ans. define $r_0 = 1$ st surface external reflection
 $r_1 = 1$ st surface internal reflection
 $r_2 = 2$ nd surface internal reflection
 $t_1 = 1$ st surface external trans. coef
 $t_1' = 1$ st surface internal trans. coef

then
$$\frac{E_R}{E_I} = \left(r_0 - \frac{t_1 t_1' r_2}{1 + r_1 r_2} \right) \Rightarrow R = 0.819 \%$$

5. A Fabry-Perot is to be used to measure the bandwidth of a 500 nm wavelength source in the range of $\Delta\lambda_{\text{source}} = 0.025$ to 0.125 nm. What maximum mirror separation and minimum mirror reflectivities are required?

Ans. one combination is $R > 53.9 \%$ and $d < 1$ mm.

6. How many fringes are visible on a Fabry-Perot with 90% mirror reflectivities and 1 cm mirror separation when illuminated with a 500nm wavelength source with a $\pm 2^\circ$ divergence angle. Ans. 24 rings.