EC591 Lab 2 Report Notes

2.1: The fringes observed in this experiment may be caused by a small misalignment of the mirrors (which tends to produce linear fringes) or by the divergence of the laser beam (which produces circular fringes)

If you insert a thin sheet of plastic in one arm of the interferometer, the fringes are distorted and become fainter due to the wavefront distortion by the corrugated plastic

$$m = \frac{2\Delta d}{\lambda} \quad \text{where} \quad \begin{cases} \lambda = 632.8 \text{ nm is the laser light wavelength} \\ \Delta d \text{ is the mirror displacement} \\ m \text{ is the number of fringes sweeping past the observation point} \end{cases}$$

For example, for $\Delta d = 3\mu m$ m should be around 9

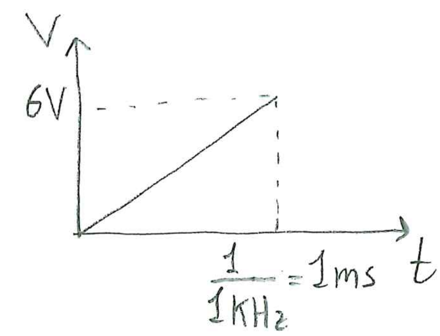
2.2A:

$$a = \frac{\Delta d}{V} = \frac{m\lambda}{2V} \quad \text{where} \quad \begin{cases} a \text{ is the piezoelectric constant (displacement per unit applied voltage)} \\ V \text{ is the applied voltage that moves the mirror by a displacement } \Delta d \\ m \text{ is the number of fringes that sweep past the observation point for a displacement } \Delta d \end{cases}$$

For most mirrors in the lab, $a \approx 300 \frac{nm}{V}$

2.2c: If the piezo-mirror moves at constant velocity v, the frequency of its reflected light is shifted to $f + \Delta f$, where $f = \frac{c_0}{\lambda}$ is the frequency of the incident light and $\Delta f = \frac{2vf}{c_0} = \frac{2v}{\lambda}$ is the Doppler shift. Then, the two waves at the output of the interferometer differ in frequency by Δf, and therefore the intensity of their superposition oscillates in time at frequency Δf.

In this experiment we apply the following voltage ramp on the piezo-mirror



Therefore the average mirror velocity is $\langle v \rangle = \frac{a \times 6V}{1ms} = 1.8 \frac{mm}{s}$ for $a = 300 \frac{nm}{V}$

A typical oscilloscope trace of the photodiode signal (proportional to the intensity of the interferometer output light) is shown in the next page. The signal oscillates in time, but not in a sinusoidal fashion, indicating that the mirror velocity is not constant across the voltage ramp. If the oscillation period in the middle portion of this trace (circled in red in the figure) is T, the Doppler shift is $\Delta f = \frac{1}{T}$ and the corresponding instantaneous mirror velocity is $v = \frac{\lambda}{2T}$

This estimate should be comparable to the average velocity computed from the piezo-electric constant, but somewhat larger because it is based on a high-frequency portion of the oscilloscope trace