OPTI 600B Homework 3 Due: September 21, 2018

1. Download the data file HW3IndexData.txt. This is a text file that contains the refractive index of N-BK7 measured at 20 wavelengths. The file also contains the coefficients for the Sellmeier dispersion formula

$$n^2(\lambda)-1=\frac{B_1\lambda^2}{\lambda^2-C_1}+\frac{B_2\lambda^2}{\lambda^2-C_2}+\frac{B_3\lambda^2}{\lambda^2-C_3},$$

where the constants B_1, B_2, B_3, C_1, C_2 and C_3 are provided by the manufacturer and λ is in units of microns. This is a non-linear equation because of the coefficients in the denominator. Fit the raw index data to the Schott dispersion formula

$$n^2(\lambda)=A_0+A_1\lambda^2+\frac{A_2}{\lambda^2}+\frac{A_3}{\lambda^4}+\frac{A_4}{\lambda^6}+\frac{A_5}{\lambda^8},$$

and provide the values of the coefficients $A_0 \ldots A_5$. Plot the difference between the predicted refracted indices for the Sellmeier and Schott formulas for wavelengths ranging from 0.3 to 2.3 microns.

2. Download the data file HW3PCAData.txt. This is a text file containing six columns of data. The first column contains the wavelength in nm and the other 5 columns correspond to the five spectral samples we showed in class. Each column has 16 wavelengths associated with it. Using principal components analysis, do the following:

a) create a 16 x 5 matrix of the data. The wavelength data is not included as a column, but is tells which row corresponds to which wavelength in the data set.
b) create the covariance matrix for this data. Note, this should be a 16 x 16 matrix.
c) list the eigenvalues associated with the covariance matrix.
d) plot the first three eigenvectors of the covariance matrix.
e) fit the second sample with the first three eigenvectors and compare the resultant curve to the original data.