OPTI 435/535 Homework #5 Due: December 5, 2011

Undergrads do problems 1-3. Grads do all problems

1. The Munnerlyn formula describes the shape pf the post-LASIK cornea. Over the central optical zone, the cornea can be approximated as a sphere of radius R1. Outside the optical zone, the cornea is a sphere of radius R2. For R1 = 8 mm, R2 = 7.8 mm and an optical zone diameter of 6 mm, the sag of the cornea is given by

$$f(r) = \begin{cases} 8 - \sqrt{8^2 - r^2} & \text{for } r < 3.0 \text{ mm} \\ 7.8 - \sqrt{7.8^2 - r^2} + C & \text{for } r \geq 3.0 \text{ mm} \end{cases}$$

(a) Find the constant C such that the cornea is continuous at r = 3.0 mm.

(b) What is the axial power of the cornea as a function of r? Assume $n_k = 1.3375$.

(c) What is the instantaneous power of the cornea as a function of r?

(d) Plot the results of parts b and c.

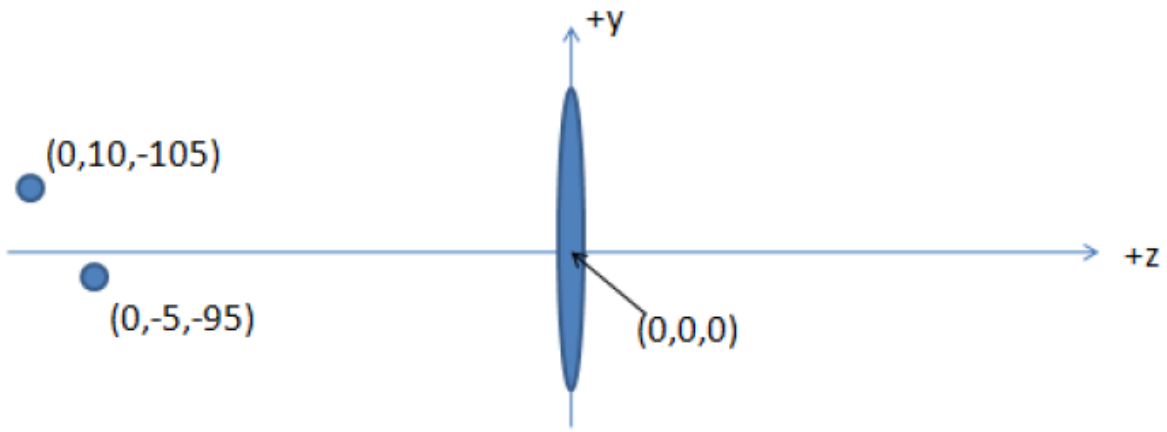
2. Suppose we have the following Scheimpflug system. A 15D thin lens is located at z = 0 in the x-y plane. Two object points are located at (0, 10 mm, -105 mm) and (0, -5 mm, -95 mm), respectively.

(a) Where are the image points formed?

(b) What is the equation of the line that passes through the two object points?

(c) What is the equation of the line that passes through the two image points?

(d) Where do these two lines intersect?



3. An electronic copy (ColorimetryData.txt) of the data for the various colorimetric functions for this problem is available on the web site. The columns of the data are: the wavelength in 10 nm steps, a spectral reflectance for a white patch, a spectral reflectance for an unknown color patch, the spectral distribution for Illuminant C, and the CIE 1931 2° color matching functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, and $\bar{z}(\lambda)$ (xbar, ybar, zbar). In the notes, these are labeled x', y' and z', but the bar notation is more universal.

(a) Plot the x,y chromaticity coordinates for spectrally pure colors (i.e. $P(\lambda) = \delta(\lambda - \lambda_o)$ where λ_o ranges from 380 nm to 780 nm in 10 nm steps).

(b) Calculate the Tristimulus values X, Y and Z and X_w, Y_w and Z_w for the color patch and the white patch respectively. Assume that Illuminant C is used to illuminate these patches for this calculation.

(c) Calculate the x,y chromaticity coordinates for the color patch and the white patch and plot them on the plot from question 1.

(d) What are the approximate values of the Dominant Wavelength, the Complementary Color and the
Excitation Purity assuming the white patch represents the White Point of the system?

(e) Calculate L*, a* and b* in the CIELAB color space for the color patch and the white patch. Again, assume the white patch is the white point for the system.

(f) Calculate ΔE between the white patch and the color patch.

**********Grads Only **********

4. Fit the points below to a 2nd order Zernike expansion (i.e. $n \leq 2$) for a normalization radius of 3 mm.

r(mm)	theta(rad)	z(mm)
2.268531537	4.525910625	-0.3406714
0.090688122	0.394872682	0.000822883
2.858828928	3.114679436	-0.550426289
2.205374142	3.1876441	-0.326992507
0.509892717	5.962904149	-0.016148879
1.666455499	4.734426741	-0.183100928
0.456445367	6.275259981	-0.012689789
0.277908028	1.731295973	-0.003755755
0.549626698	1.335002163	-0.018708401
2.54022574	2.274885074	-0.430211919
2.130476538	3.06050893	-0.305045528
1.343851106	3.707783486	-0.119988731
1.940619109	5.497056489	-0.250839262
0.958501009	3.303513206	-0.060626631
2.924674713	5.80417449	-0.574166323
2.918002861	1.211767778	-0.565387319
1.095808545	0.573527706	-0.079312407
0.46898854	2.508084566	-0.01338962
1.137233164	4.803472824	-0.08454648
1.489102062	3.19066	-0.148331149

(HW5 Data.txt)