OPTI 435/535 Homework #4 Due: November 23, 2009

Undergrads do problems 1-3. Grads do all problems

1. The Munnerlyn formula describes the shape of 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 mm.

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

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

(d) Plot the results of parts b and c

2. Show that $Z_4^{-4}(\rho,\theta)$ and $Z_4^2(\rho,\theta)$ are orthogonal. Show that $Z_2^2(\rho,\theta)$ and $Z_4^2(\rho,\theta)$ are orthogonal.

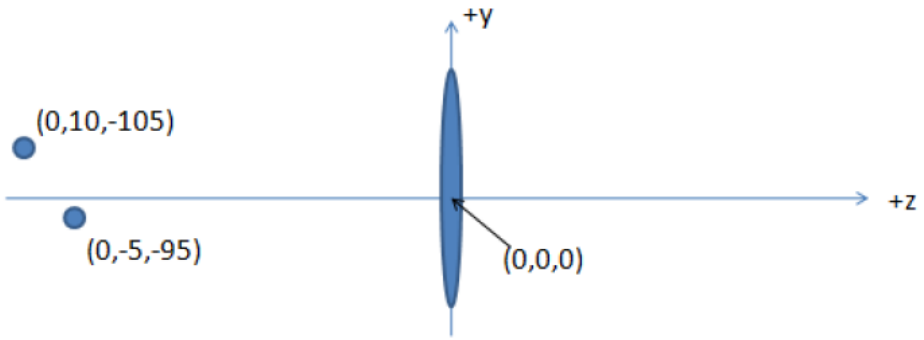
3. Suppose we have the following Scheimpflug system. A 15 D thin lens located at z = 0 in the x-y plane. Two object points are located at (0, 10 mm, -105 mm) and (0, -5mm, -95mm), respectively.

   (a) Where are the image points formed?

   (b) What is the equation of the line the 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?



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 |