OPTI 435/535 Midterm October, 2008

Answer all questions and return to the Optical Science Main Office within 24 hours of picking up the test. You can use any resources at you disposal except other people. Show all work and please keep you results confidential as others may still be taking the exam.

1. The mean wavefront error over a normalized pupil is given by

$$\overline{W} = \frac{1}{\pi}\int_0^{2\pi}\int_0^1 W(\rho,\theta)\rho d\rho d\theta$$

and the wavefront variance is given by

$$\sigma_W^2 = \frac{1}{\pi}\int_0^{2\pi}\int_0^1 \left(W(\rho,\theta)-\overline{W}\right)^2\rho d\rho d\theta$$

where $W(\rho,\theta)$ is the wavefront error. For the following wavefront, show that the wavefront variance is just the sum of the squares of the Zernike expansion coefficients a_{nm}.

$$W(\rho,\theta) = a_{2,2}Z_2^2(\rho,\theta) + a_{3,1}Z_3^1(\rho,\theta)$$

2. We saw in homework 3 that the spot pattern from a Shack Hartmann wavefront sensor contracts with myopia. Suppose we have a lenslet array with lenslet spacing of 100 microns and our sensor can accurately separate spots that are spaced by 10 microns. What is the required focal length of the lenslets, if we wish to be able to measure up to 10 diopters of myopia?

3. The sag of a conic surface is given by

$$f(x,y) = \frac{1}{K+1}\left[R - \sqrt{R^2 - (K+1)r^2}\right]$$

(a) What are the First and Second Fundamental forms?
(b) What are the Gaussian and Mean Curvatures?
(c) What are the Principal Curvatures?

4. Suppose you have two lenses with prescriptions +1.00 / +2.00 x 40º and +1.00 / +2.00 x 30º. What is the combined power of these lenses? **Give your answer in both plus cylinder form and minus cylinder form.**