OPTI 435/535 Homework #2 Due: October 7, 2021

Undergrads do problems 1 through 3
Grads do all four problems

1. A wavefront error is given by $W(r,\theta) = -0.001r^2 - 0.0005r^2 cos2\theta + 0.00005r^4$. What is the power error $d\phi$ associated with this wavefront? For the horizontal meridian, plot $d\phi$ for pupil diameters ranging from 2 mm to 8 mm. Plot $d\phi$ as a function of θ for a pupil diameter of 4 mm. (Note that r is the *real* radial coordinate in the pupil, so r ranges from 1 mm to 4 mm for pupil diameters of 2 mm to 8 mm).

2. The sag of a paraboloid is given by $z = \frac{x^2+y^2}{2R}$. What is the Mean Curvature H of the surface? Show that the Mean Curvature of the paraboloid is the same as a sphere of radius R at the origin.

3. The picture below was taken at a distance of 30 feet from the storage container. The height of the storage container in 8 feet. What is the fundamental spatial frequency of the ribs in the side of the storage container in cyc/deg? What are the fundamental spatial frequencies in cyc/deg of the horizontal and vertical mortar lines in the brick wall? State your assumptions. The original image is available on the class website.

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

4. In class we showed that the spherical aberration can be obtained from raytracing data from

$$d\phi = \frac{n'}{P'M'} - \frac{n'}{P'F'}$$

where $P'M'$ is the distance from the rear principal plane to the marginal ray focus, $P'F'$ is the distance from the rear principal plane to the rear focal point (i.e. the rear focal length) and n' is the index of the vitreous humor. Plot the spherical aberration of the Gullstrand-LeGrand and Arizona Eye models for ray heights ranging from 0 to 4 mm.