**OPTI 340 Spring 2012**

**Midterm Exam #1**

February 20, 2012

Open books, notes, homework

Calculator may be used

Individual work only

Arizona Code of Academic Integrity applies

8:00 AM till 8:50 AM (50 min.)

3 problems

Professor Yuzuru Takashima

**Problem 1: (25 pt)**

**Part A (10 pt)**

Consider a thick plano-convex lens depicted in Fig. 1a. Thickness of the lens is 20 mm. Index of refraction of the lens material is 1.5. The object is located at infinity. The back focal length is 80 mm.

1. **(5 pt)** Calculate the value for R2.
2. **(5 pt)** Calculate focal length of the thick lens.



Fig. 1a

**Part B (15 pt)**

Consider a thick lens depicted in Fig. 1b. R1 and R2 are the radius of the first and the second surface, respectively. Assume R2 = -R1 (equi-convex lens). Thickness of the lens is 40mm. Index of refraction of the lens material is 1.5. The thick lens is used under the following conditions, 1) and 2).

1) Distance between object and image is 200 mm.

2) Magnification: M = －1.

1. **(5 pt)** Calculate the value for R1.
2. **(5 pt)** Calculate focal length of the thick lens.
3. **(5 pt)** Locate the 1st and 2nd principal points of the thick lens



Figure 1b

**Problem 2: (20 pt)**

Figure 2 shows Y and X ray fan diagrams at normalized field height H = 0 of an optical system having an F-number of 10.

1. (10 pt) Using the diagram, identify wave aberration coefficients for Defocus (W020) and Spherical Aberration (W040) in micrometer. Assume only Defocus and Spherical Aberration are present.
2. (5 pt) Sketch wave aberration as a function of normalized pupil coordinate yp. Clearly indicate the peak-to-valley value of the wave aberration and its location on yp-axis.
3. (5 pt) Sketch longitudinal aberration as a function of normalized pupil coordinate yp. Clearly indicate the maximum amount of longitudinal aberration at yp=1.



Figure 2

**Problem 3: (15 pt)**

Figure 3 shows a spherical interface with a radius of curvature R (R>0). An incoming ray (RT) is travelling towards an on-axis point M and is refracted at the point T on the interface. The point M is located at a distance of R (n’/n) measured from the point C, n and n’ are index of refraction of the medium before and after refraction, respectively. We assume that n’ > n. The optical axis is taken along the z-direction.

1. (5 pt) Find the locations of the on-axis point M’ where the refracted ray intersects with the optical axis. No proof is needed.
2. (10 pt) Prove that a converging spherical wave toward the point M has no spherical aberration, or W040 = 0, upon refraction at the interface.



Figure 3