OPTI 201R Midterm 2 November 15, 2016

Do all problems and show your work. Credit is not given for answers only. Don't spend too much time on any one problem. Use separate sheets of paper and don't cram your work into the spaces below. As in the notes, zF and z'F are the object and image distances measured from the front and rear focal points. The distances z and z' are the object and image distances measured from the front and rear principal plane. Questions 1-5 are worth 8 points each. Questions 6-8 are worth 20 points each.

Thin lens or general system $\phi = \frac{1}{f}$	Focal Lengths $f'_R = n'f \qquad f_F = -nf$
Single surface $\phi = \frac{n' - n}{R}$	Total power of two elements $\phi = \phi_1 + \phi_2 - \left(\frac{t'_1}{n'_1}\right)\phi_1\phi_2$
Front Principal Plane $\delta = \frac{d}{n} = \frac{\phi_2}{\phi}\left(\frac{t'_1}{n'_1}\right)$	Rear Principal Plane $\delta' = \frac{d'}{n'} = -\frac{\phi_1}{\phi}\left(\frac{t'_1}{n'_1}\right)$
Front Focal Distance $FFD = f_F + d$	Back Focal Distance $BFD = f'_R + d'$
Gaussian Imaging Eq. $\frac{n'}{z'} - \frac{n}{z} = \frac{1}{f}$	Newtonian Imaging Eq. $z_F z'_F = f_F f'_R$
Transverse Magnification $m = \frac{nz'}{n'z}$	Longitudinal Magnification (small shift) $\overline{m} = \frac{n'}{n} m^2$
Nodal Points $z_{PN} = z'_{PN} = f_F + f'_R$	Mirrors Thickness and indices switch sign after reflection

1. Given the object distance zF = -120.000 mm, an object space index n = 1.50, and a lens of effective focal length f = -21.000 mm, what is the front focal length fF and the magnification m?

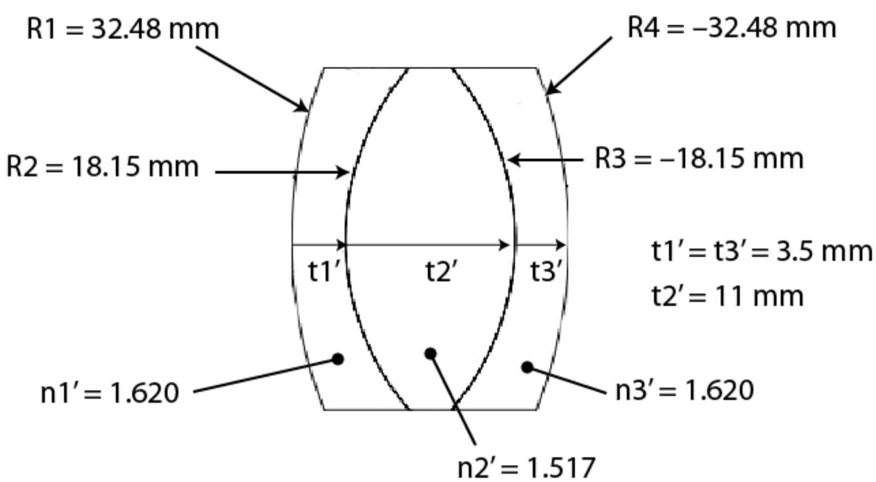
2. Given the object distance zF = -120.000 mm, an object space index n = 1.00, and a lens of front focal length fF = -42.000 mm, what is the effective focal length f and the magnification m?

3. Given the object distance zF = 160.000 mm, an object space index n = 1.33, and a magnification m = -1.500 mm, what is the effective focal length f and the front focal length fF?

4. Given the image distance z'F = 80.000 mm, an image space index n' = 1.33, and a lens of effective focal length f = 21.000 mm, what is the rear focal length f'R and the magnification m?

5. Given the image distance z'F = 80.000 mm, an object space index n' = 1.33, and a lens of rear focal length f'R = 42.000 mm, what is the effective focal length f and the magnification m?

6. The parameters of a Hastings triplet are shown in the figure below. Use Gaussian reduction on the lens above to find the location of all six cardinal points, as well as the FFD and BFD. Show all work.



7. A Gregorian telescope has two reflective mirrors. The first mirror has a radius of curvature of $R1 = -500$ mm. The second mirror lies to the left of the first mirror such that $t_1' = -150$ mm. The radius of curvature of the second mirror is $R2 = 125$ mm.

(a) Sketch the telescope and label the vertices, V1 and V2.

(b) Using Gaussian reduction, find the overall focal length of the telescope.

(c) Where are the principal planes located with respect to the vertices V1 and V2?

8. A system consists of two thin lenses separated by a distance of 8 mm. The focal length of the first lens is 3.75 mm and the focal length of the second lens is 10 mm. An object is located 4 mm to the left of the first lens. The object has a height of 0.5 mm.

(a) What is the focal length of the system?

(b) Where is the image formed with respect to the last surface?

(c) How big and what is the orientation of the image?