Optics I: Theory CPHY 6/72250
Assignment 2.

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Due: Oct. 5, 2017

1. Consider a graded index fiber with refractive index $n = n_1(1 - \frac{1}{2}\alpha^2 y^2)$ and radius a. A ray is incident from material with index n_0 at its center, making an angle θ_0 with the fiber axis. Show that, in the paraxial approximation, the numerical aperture is

$$NA = n_0 \sin\theta_0 \approx n_1 \alpha a \tag{1}$$

where θ_0 is the angle for which the ray trajectory is confined within the fiber.

2. Derive an expression for the transfer matrix of a system comprised of free space/thin lens/free space as shown below. Show that if the imaging condition

$$\frac{1}{d_1} + \frac{1}{d_2} = \frac{1}{f} \tag{2}$$

is satisfied, all rays originating from a single point y_1 in the input plane reach the output plane at the single point y_2, regardless of their angles. Also show that if $d_2 = f$, all parallel incident rays are focused by the lens onto a single point in the output plane.