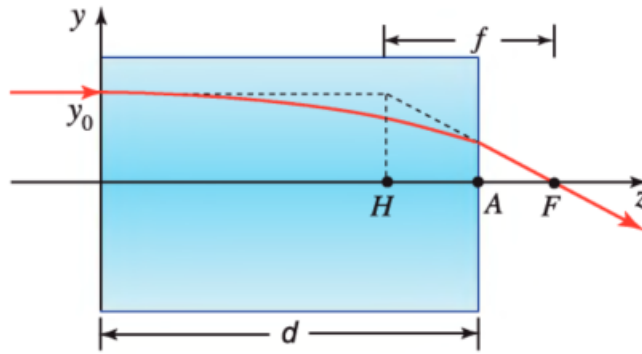


## ECE 448/ECE 544 (Spring 2025): Homework 3

1. (Based on Exercise 1.3-1) *The GRIN Slab as a Lens.*

- a. Show that a graded-index slab of length  $d < \pi/2\alpha$  and refractive index  $n^2(y) = n_0^2(1 - \alpha^2 y^2)$  that is located in air ( $n = 1$ ) acts as a cylindrical lens (with focusing power in the  $y$ - $z$  plane) of focal length  $f = 1/(n_0 d \alpha \sin \alpha)$ .
- b. Show that the principal point  $H$  at the intersection of the forward projection of the incident ray and the backward projection of the transmitted ray lies at a distance  $\overline{AH} = [1/(n_0 \alpha)] \tan(\alpha d/2)$ .
- c. Sketch the ray trajectories in the special cases  $d = \pi/\alpha$  and  $d = \pi/(2\alpha)$ .



2. (Based on Exercise 1.4-9) *Ray-Transfer Matrix of a GRIN Slab.*

- a. Determine the ray-transfer matrix of a graded-index slab of thickness  $d$  and refractive index  $n^2(y) = n_0^2(1 - \alpha^2 y^2)$  ignoring the refraction of light at the entrance and the exit of the slab.
- b. Repeat the previous part including the refraction of light at the entrance and the exit of the slab.