

## ENEE 408E Optical System Design

### Design Problems #4, November 16, 2004

Due November 30, 2004

**Questions (1) and (4)-(8) are potential examination questions. All questions are good for revising for the next examination.**

(1) A Gaussian beam is focused by a thick, biconvex lens with  $R_1=100\text{mm}$ ,  $R_2=-100\text{mm}$ ,  $d=20$ , made of LAK8 glass ( $n=1.713$ ). Calculate the position, and size of the new beam waist when:

(a) The incoming Gaussian beam has its beam waist at the lens with  $w_0=5\text{mm}$ ,  $\lambda_0=488\text{nm}$ .

(b) The incoming Gaussian beam has  $w_0=0.1\text{mm}$ ,  $\lambda_0=1.55\mu\text{m}$ , and the lens is situated 1m from the beamwaist.

(2) Repeat question (1) using Code V. Set up the lens in the usual way, and then use the Gaussian beam analysis option.

(3) Design a GRIN lens system of reasonable parameters to collimate a laser beam of wavelength 780nm with spot size  $15\mu\text{m}$  to a beam  $\sim 1\text{mm}$  in diameter.

(4) A laser beam of spot size 10mm and wavelength 880nm is allowed to enter a medium with a quadratic index profile, with  $n_0 = 1.5$ , and  $n_2 = 0.03 \text{ m}^{-2}$ . The beam enters a section of this medium 1m long with its beamwaist at the front face. The beam emerges from the medium and travels 1m further. What are its spotsize and radius of curvature at this point?

(5) Where is the beamwaist, and what is the minimum spot size of a Gaussian beam in a resonator with  $R_1 = 1.5\text{m}$ ,  $R_2 = 3\text{m}$ ,  $d = 1\text{m}$  ? Take  $\lambda_0=488\text{nm}$ .

(6) A  $1.55\mu\text{m}$  laser has a minimum spotsize of 0.5mm. Design a GRIN lens for focusing this beam to a  $10\mu\text{m}$  spotsize. Place the GRIN lens at 10mm from the original beamwaist.

(7) A  $1.06\mu\text{m}$  laser has a resonator with two concave mirrors of radii 4m and 2m, respectively, placed 0.5m apart. Calculate:

(a) the spotsize of the resultant Gaussian beam

(b) the location of its beamwaist.

(8) Design a symmetrical resonator ( $R_1 = R_2$ ) with a minimum spotsize of 0.2mm for  $1.3\mu\text{m}$  and a spacing of 200mm.