PHGN 480: Laser Physics due 17 Nov 2010
Homework 6

1) Svelto 5.3. You can work through 5.2 as a guide (5.2 solutions in book).

2) Svelto 5.8. Modify the Mathematica file to work this problem numerically. Use L_1 = 50cm, L_2 = 100cm, and plot the stability parameter vs the lens focal length, f. Also plot the beam sizes at the lens and two end mirrors vs. f for the ranges of f that are stable.

3) Svelto 5.12.

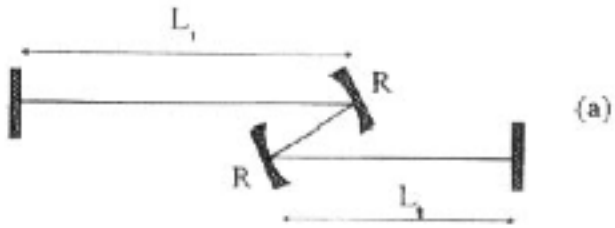
4) As we discussed in class, the ABCD matrix for a parabolic gradient index profile

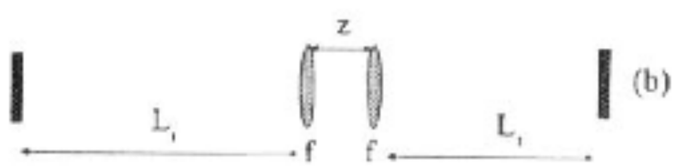
$$n(r) = n_0\left(1 - \frac{k_2}{2k}r^2\right) \text{ is } \begin{pmatrix} \cos\beta z & \frac{1}{n_0\beta}\sin\beta z \\ -n_0\beta\sin\beta z & \cos\beta z \end{pmatrix},$$

where $\beta = \sqrt{k_2/k}$. (Note the placement of n_0 in the matrix – I had neglected these in class.) Suppose the medium is thin. Show that this ABCD matrix reduces to that of a thin lens, and find the effective focal length of the thin gradient index lens.

5) Svelto 5.15

6) A typical cw-pumped Ti:sapphire laser uses a four-mirror resonator of the type shown in the figure (a) below. The Ti:sapphire crystal consists of a plate inserted at Brewster angle between the folding mirrors. Neglecting the astigmatism caused by the crystal and the angled, curved mirrors, we can represent the cavity by the simpler cavity shown in figure (b).





Assuming the following parameters that are typical of a Kerr-lens mode-locked laser: L_1 = 400mm, L_2 = 1000mm, f = 50mm. Using the ABCD code, set up the ABCD matrix and make a plot of the stability parameter as a function of the curved mirror separation z. Also plot of the cavity mode size at each end of the resonator vs. z.