Homework Set #4 **Due: 4-23-12**

(1) Plot $t_{i\parallel}$ and $t_{i\perp}$ using a plot similar to that of Fig. 3.13. (Whenever I request a plot, I expect good technique – properly labeled axes, well chosen axis ranges, etc.)

(2) A 10 MW beam is sent through a cylinder made of fused silica at normal incidence. The beam is spatially uniform and round with a 1 cm diameter. Find the peak intensity in the fs at the fs – air rear interface and compare to that at the air – fs front interface found in class. Also compare to the average intensity in the medium. Ignore multiple reflections.

Recall: Fused silica (fs) is an amorphous version of quartz with n ≈ 1.46. It is harder to damage than most glasses and transmits better in the UV. It and BK-7 glass are among the most popular materials for laser components.

This shows that damage is more likely to occur at the rear of such a component than at the front. It is rare to place simple cylinders in the path of a high power laser beam, but uncoated lenses are often used, and a similar argument likely applies to them even thought their surfaces aren't flat.

(3) The Evanescent Wave I

Derive both the complex and real expressions for B_t in an evanescent wave (s-polarization) given in class. The real version was (and also showing the E-field for completeness):

$$\vec{E}_t = E_{ot} e^{-\alpha z} \cos(Kx - \omega t)\hat{y}$$

$$\vec{B}_t = \frac{E_{ot}}{\omega} e^{-\alpha z}\left[\alpha \sin(Kx - \omega t)\,\hat{\imath} + K \cos(Kx - \omega t)\hat{k}\right]$$

with α and K the absorption coefficient and propagation constant as defined in class.

(a) Start by writing the transmitted B-field for the case $\theta < \theta_c$ in complex notation.

(b) Now finish by modifying your solution to treat the case $\theta > \theta_c$.

(4) The Evanescent Wave II

Show the evanescent wave (real version) satisfies:

(a) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

(b) $\vec{\nabla} \cdot \vec{E} = 0$

The remaining Maxwell's eqns are also satisfied, but you're probably convinced now(?).

(5) text 3.25

(6) text 3.29