33-353 — Intermediate Optics Thursday, Sept-23, 2010

HW assignment, week 5 due: Wednesday, Sept-29, 2010 – before class

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1. Planar glass plate **(4 pts)**

Using Snell's law, show analytically that a light beam impinging on a transparent planar glass plate exits that plate parallel to the incident direction. What is the parallel displacement of the beam behind the glass plate as a function of glass thickness d, glass index n and the angles θ_i, θ_t?

Discuss how the light path taken through the glass plate for an incident angle, $\theta_i > 0$, (which is longer than it would have been in air) complies with Fermat's principle.

2. Dispersion in glass plate **(3 pts)**

Hecht, problem 4.20:

A narrow white beam strikes a slab of glass (d = 10 cm) at an angle $\theta_i = 60°$. The indices of refraction of the glass are $n_{\text{red}} = 1.505$ and $n_{\text{vio}} = 1.545$ for red and violet, respectively. Determine the diameter of the beam emerging out of the far glass interface.

3. Critical angle **(3 pts)**

Hecht, problem 4.58:

A glass block ($n_{\text{gl}} = 1.55$) is covered with a water layer ($n_{\text{gl}} = 1.33$). What is the critical angle at the glass/water interface?

4. Transmission and reflection amplitudes **(3 pts)**

From reviewing the electrostatic boundary condition at an interface that separates media of n_i and n_t ($> n_i$), show that the transmission and reflection amplitudes for a light beam with polarization of $\vec{E}$ out of the plane of incidence are related as $t_\perp - 1 = r_\perp$.

5. Transmission and reflection amplitudes II **(3 pts)**

Show analytically by starting from the Fresnel equations for $t_\perp$ and $r_\perp$ that $t_\perp - 1 = r_\perp$ is true for all θ.

6. Polarization angle **(4 pts)**

Show that the polarization angles for internal and external reflection at a given interface complement as $\theta_p + \theta_p' = 90°$.