PHYSICS 3600 Optics and Photonics I
Winter 2006
Assignment #5

Handout: Wednesday, March 22, 9:00 am

Due: Monday, April 3, 9:00 am

Note: There are five problems in this assignment. Please turn over to find Prob#5.

1. (20 points) (P&P, Problem 20-1, p. 423)

Show that the vanishing of the reflection coefficient in the TM mode, the following equation leads to Brewster's law:

$$r = \frac{E_r}{E} = \frac{n^2 \cos\theta - \sqrt{n^2 - \sin^2\theta}}{n^2 \cos\theta + \sqrt{n^2 - \sin^2\theta}}$$

2. (20 points) (P&P, Problem 20-11, p. 424)

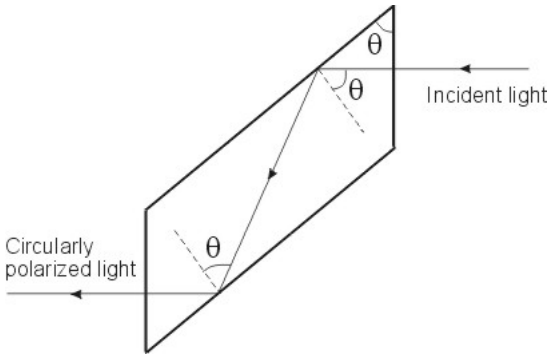
Light is incident upon an air-diamond interface. If the index of diamond is 2.42, calculate the Brewster and critical angles for both (a) external and (b) internal reflections. In each case distinguish between polarization modes.

3. (20 points) (P&P, Problem 20-15, p. 424)

A Fresnel rhomb is constructed of transparent material of index 1.65.

(a) What should be the apex angle θ?

(b) What is the phase difference between the TE and TM modes after both reflections, when the angle is 5% below and above the correct value?



4. (20 points) (P&P, Problem 24-5, p. 519)

A step-index fiber 0.0025 inch in diameter has a core of index 1.53 and a cladding of index 1.39. Determine (a) the numerical aperture of the fiber; (b) the acceptance angle (or maximum entrance cone angle); (c) the number of reflections in 3 feet of fiber for a ray at the maximum entrance angle, and for one at half this angle.

(Please turn over.)

5. (20 points) (P&P, Problem 24-6, p. 519)

(a) Show that the actual distance x_s a ray travels during one skip distance is given by

$$x_s = \frac{n_1 d}{\sin\theta}$$

where θ is the entrance angle and the fiber is used in air.

(b) Show that the actual total distance x_t a ray with entrance angle θ travels over a total length L of fiber is given by

$$x_t = \frac{n_1 L}{\left(n_1^2 - \sin^2\theta\right)^{1/2}}$$

(c) Determine x_s, L_s, and x_t for a 10-m-long fiber of diameter 50 μm, core index of 1.50, and a ray entrance angle of 10°.