Assignment 1: Fresnel’s Equations; Reflection and Refraction

1. What is the rms value of the electric field of the radiation from a 100-W light bulb at a distance of 1 m?

2. The electric and magnetic fields \( E \) and \( B \) are three dimensional harmonic waves travelling in space. What is the average value of the Poynting vector \( S \)? What is the direction of \( S \)?

3. The critical angle for total internal reflection for a certain substance is exactly 45\(^\circ\). What is the Brewster angle for external reflection?

4. Light enters normally into glass (\( n = 1.5 \)) from air. What is the percentage of the incident power lost in reflection at the air-glass interface?

5. Using your favourite computational software (such as Matlab), plot the reflectivity \( R = |r|^2 \) for TE polarized light. Assume internal reflection from glass (\( n = 1.5 \)) into air.

6. Use the Fresnel Equations to prove that unpolarized light incident at \( \theta_p = \pi/2 - \theta_t \) results in a polarized reflected beam.

7. Derive and plot the phase difference \( \Delta \phi = \phi_\perp - \phi_n \) versus the angle of incidence \( \theta_i \) when total internal reflection is taking place from a water-air interface. The light is \( P \)-polarized (\( TM \)). The refractive index for water is 1.3. Also illustrate the directions of the polarizations.

8. Polarized light is externally incident on an air-glass interface at an angle of \( \pi/4 \). The refractive index for glass is 1.5. The plane of polarization of the incident light is at an angle of \( \pi/4 \) to the plane of incidence. Find the percentages of reflected and transmitted light.

Chapter 1 and 3 of Bennett; Sections 4.6, 4.7 of Hecht.