Physics 214 Fall 98—Problem Set 7—[Total Points: 7] Due Before 5:00 pm October 16 1998

**Homework**

1. Reading Assignments from Serway
   Week Beginning October 6: 17.4; 35.3 - 35.8; 36 (optional); 37.1 - 37.4
   Week Beginning October 13: 39.0 - 39.4 (optional); 38.0 - 38.6

2. Index of Refraction
   Ocean waves moving at a speed of 4.0 m/s are approaching a beach at an angle of 30 degrees to the normal to the beach. The speed of water waves in shallow water is proportional to the square root of the depth of the water. Suppose the water depth changes abruptly and the wave speed drops to 3.0 m/s. Close to the beach, what is the angle between the direction of wave motion and the normal? Can you explain why most waves come in normal to a shore even though at large distances they approach at a variety of angles?

3. Critical Angles
   An optical fiber consists of a glass core (index of refraction $n_1$) surrounded by a coating (index of refraction $n_2 < n_1$). Suppose a beam of light enters the fiber from air at an angle $\Theta$ with the fiber axis as shown in the figure below.

   ![Diagram of optical fiber](image)

   a) Show that the greatest possible value of $\Theta$ for which a ray can be propagated down the fiber is given by $\Theta = \sin^{-1}\left(\frac{n_2^2}{n_1^2}\right)^{1/2}$

   b) Assume the glass and coating indices of refraction are 1.58 and 1.53, respectively, and calculate the value of this angle.

4. Double Slit Interference—Intensity
   Consider a conventional double-slit interference experiment, but where one of the slits is wider than the other. The intensity of the light reaching the screen from the wide slit alone is $4I_0$, while that from the narrow slit alone is $I_0$. Use phasors to compute the intensity of the light on the screen when both slits are open. Express your result in terms of $I_0$ and $\phi$, the phase difference between waves coming from the two slits.

5. Sound Wave Interference
   $S_1$ and $S_2$ are two coherent point sources of sound that are a distance $d$ apart along the $y$ axis:

   ![Diagram of sound wave interference](image)

   The sources emit sound of the same frequency, and are in phase.

   a) Consider a point $B$, 4 m along the $x$ axis. Is there constructive or destructive interference at B if the wavelength of the sound is
      (i) $\lambda = 1$ m.
      (ii) $\lambda = 2$ m.
      The distance $d$ between the sources is 3 m.

   b) For the destructive interference case found in part (a), what relative intensity $\frac{I_2}{I_1}$ of the sources will produce zero sound level at B?
6. Double Slits

A double slit arrangement with slit separation \( d \) is illuminated by coherent light of wavelength \( \lambda \). The top slit is covered by a piece of glass of thickness \( t \) and refractive index \( n \). An interference pattern is observed on a screen distance \( D \) away, where \( D \gg d \).

a) At what angle, \( \theta \), do we have the principal \((m = 0)\) maximum of the interference pattern? (You may assume that \( \theta \) is a small angle.)

b) You now want to put a second piece of glass over the top slit of thickness \( t' \) and refractive index \( n' \) so that the new interference pattern that results has its maxima where the minima occurred in the pattern of part (a). Given \( n' \) and \( \lambda \), what is minimum thickness that \( t' \) can be?

**Computing**

1. Huygens

The following section from the lab manual for *huygens* needs to be completed and handed in:

- Section H1: Thin Slits

Before starting please read the Introduction and Introduction to the Simulation sections.