Problem Set 12

Due: Tuesday, Apr. 29, 2003, at 11:59 pm.

Reading:

1. Pain, 5.5.
2. Pain, 5.9.
5. A piston is located at \( x = 0 \), adjacent to a fluid extending throughout \( x > 0 \). At \( t = 0 \) there is an incoming wave having an initial shape \( \xi_{nc}(x, 0) = f(x) \). In addition, the piston is set in motion with a specified displacement \( B(t) \). Find a formal solution for \( \xi(x, t) \).

6. A layer of water overlies another liquid of unknown acoustic impedance. Assume both media to be of semi-infinite extent. A generator of ideal plane waves (parallel to the interface) is placed in the water. If a pressure condensation is reflected as a rarefaction of magnitude half that of the original pulse, what is the unknown impedance?

7. Two adjacent semi-infinite media (\( \rho_1, c_1, Z_1 \) for \( x < 0 \) and \( \rho_2, c_2, Z_2 \) for \( x > 0 \)) are separated by a thin plate of mass per unit area \( \mu \). Find the velocity transmission and reflection coefficients for a sinusoidal wave of angular frequency \( \omega \) sent in from the left. I sketched this problem on the board, you just need to fill in the details.

8. Two pulses are simultaneously incident from opposite sides on a plane boundary separating two semi-infinite media of parameters \( \rho_1, c_1 \) and \( \rho_2, c_2 \). Is it possible to arrange the relation between these pulses in such a way that there will be no reflected waves in one of the two media? (That is, in such a way that the solution does not contain any function representing a waves traveling away from the boundary surface in one of the media.)

9. In the problem of the transmission of a sinusoidal waves by a thin plate assume that the medium on both sides of the plate is air at standard temperature and pressure.

(a) Determine the characteristic frequency for a sheet of paper, assuming that an \( 8'' \times 10'' \) sheet has mass 3.4 grams.
(b) Show that, in general, the characteristic wavelength is \( \lambda = \pi a (\rho / \rho_1) \), where \( a \) is the thickness of the plate, \( \rho \) is its density, and \( \rho_1 \) is the density of the air.

(c) Find the thickness of a plane of glass which has a characteristic frequency corresponding to middle C.