ECE 537 **HW #1** **Fall 2006**

Univ. of Illinois **Due: Wed Sept. 6, 2006** **Prof. Allen**

Topics of this homework: Basic Acoustics and units, dB, Intensity calculations, the Helmholtz resonator

1. The speed of sound:
   (a) What is the formula for the speed of sound?
   (b) Identify the variables.
   (c) What is the meaning of γP_0?
   (d) Numerically show that $c^2\rho_0 = \gamma P_0$. Namely given numerical values for each of the constants, show that the left is equal to the right.
   (e) Does P_0 depend on temperature? Explain?
   (f) Does ρ_0 depend on temperature or P_0? Explain.
2. Basic equations of sound propagation:
   (a) Write out the 2x2 matrix equation that describes the propagation of 1 dimentional sound waves in a tube having area A:
   (b) Rewrite these equations as a second order equation in terms of the pressure P, and thereby find the formula for the speed of sound in terms of Z and Y:
3. Assume that a flash bulb puts out 50 Joules when it is triggered, and it lasts for 20 μs. How much power is delivered while the flash is present, assuming the lumination is constant during the interval?
4. A person is speaking at an intensity of I_0 66 dB-SPL, as measured with a sound level meter at 1 meter.
   (a) Find the total power in the voice assuming that the level is uniform around the head.
   (b) Find the total power assuming that the intensity varies as
   $$I(\theta,\phi) = I_0 cos(\theta/2) cos(\phi/2) \quad (1)$$
   where θ is the angle in the horizontal plane and ϕ in the vertical plane. where $\theta = 0, \phi = 0$ corresponds to "stright ahead."
5. Bels
   (a) How many millibels [mB] in 1 bel [B]?
   (b) Give the formula for the intensity in mB units.
   (c) Give the formula for the sound pressure level in cB (centibel) units.
6. Demonstrate that $P_{ref} \equiv 20$ μPa is the same as $I_{ref} \equiv 10^{-12}$ [W/m^2].
7. A bottle has a neck diameter of 1 [cm] and is 1 cm long. It is connected to the body of the bottle which is 5 cm in diameter and 10 cm long.
   (a) Find the resonant frequency of the bottle.