Noise Engineering **Class 2014_Fall**

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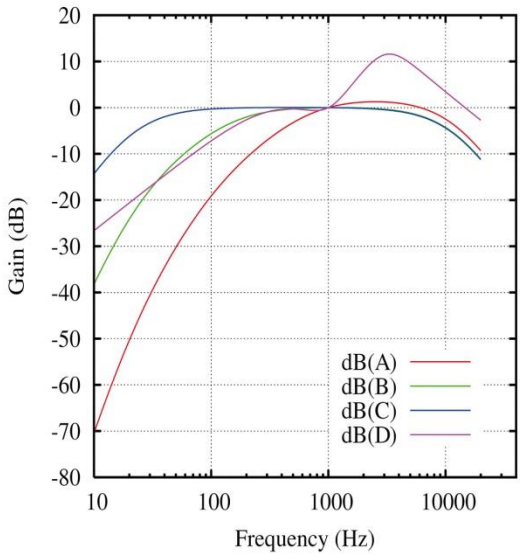
HomeWork #1 (Due 10/29)

PART I Basic problem

1. Speaker1/speaker2 can radiate 100Hz/1kHz pure tone noise each.

a) At a certain place, SPL by speaker1 and speaker2 are 80dB / 70dB respectively. What will be the SPL at the place when both speakers are turned on? (10pts)

b) Calculate the answer of a) in dB(A) using following weighting curve. (10pts)



2. The acoustic pressure in a spherically symmetric wave is given by $p = \frac{A}{r}\cos[\omega(t - c^{-1}r)]$ where A is a constant. In term A, ω, c, ρ_0, and t, how much mass m passes per unit time out through a fixed spherical surface of radius R_0 in the $R_0 << c/\omega$? Assume that R_0 is larger than the radius of the source and that A is sufficiently small for nonlinear effects to be negligible. (15pts)

3. The following duct is filled with air. Plane wave is propagated from the flat type speaker which is installed on the left side of the duct. Frequency of plane wave is 400Hz. Inner radius of duct is 5cm. And one point's SPL(sound pressure level), 3m away from speaker's vibrating surface, is 100dB. Determine the following. (25pts)

a) p'_{rms}

b) intensity (W/m^2)

c) acoustic power (W) passing through the vertical plane of duct

d) speaker diaphragm's vibrating amplitude (peak value of deflection)
(hint: using the value from a))

※ Note) Dissipation in a medium is negligible.

4. Answer the following. (25pts)

a) Sound wave vertically enters to the medium from the other medium. Express the amplitude of reflected wave and transmitted wave by amplitude of incident wave and property of medium.

b) In this situation, what happens to the frequency and the wavelength of transmitted wave? Compare to the frequency and wavelength of incident wave.

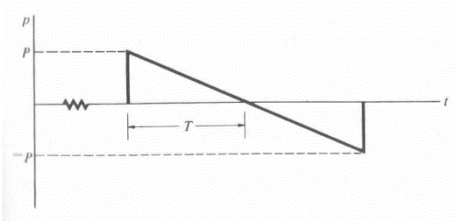
c) Sound wave vertically enters to the wall with surface density of m'(kg/m^2). Express the amplitude of reflected wave and transmitted wave by amplitude of incident wave and property of medium.

d) Compare the result of a) and c) by using the concept of acoustic impedance. Does this relationship equally matched to the duct acoustics? Using these results, estimate the relationship between amplitude of incident wave, reflected wave and transmitted wave when the wall with surface density of m(kg/m^2) exists between the medium with different property.

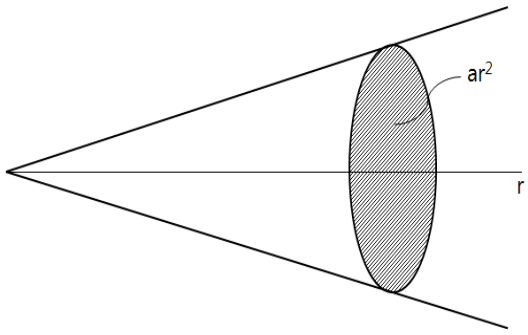
5. Ray theory can be applied only when the speed of sound 'continuously' changes in the medium. Explain the reason (in terms of energy) why reflection in the medium can be neglected during propagation. (15pts)

PART II Advanced problem

6. An idealized sonic-boom pressure waveform (acoustic pressure versus time) is shown in the figure. Assume that such a wave is propagating freely through air (sound speed c, ambient density ρ) and derive an expression in terms of P, T, ρ and c for the total acoustic energy carried across unit area normal to the wave front during passage of the sonic boom. (15pts)



7. Answer the following. (20pts)



a) Show that the pressure disturbances in a conical horn is expressed as the following form.

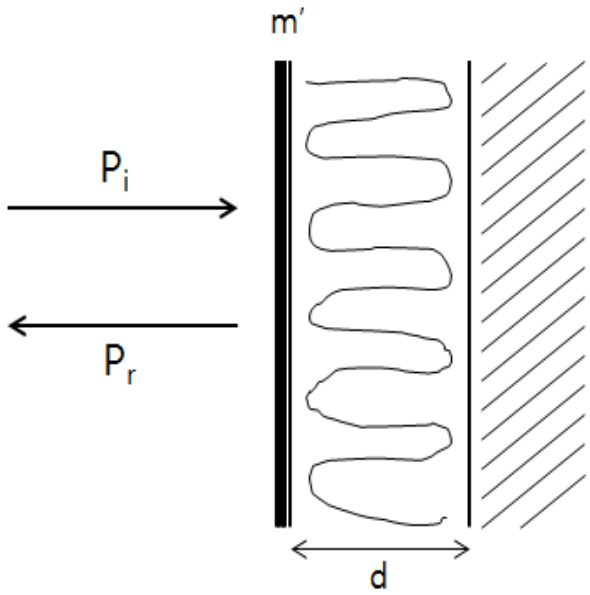
$$p'(\mathrm{r},\mathrm{t}) = \frac{f(t-\frac{r}{c})}{r} + \frac{g(t-\frac{r}{c})}{r}$$

b) 1kHz tonal sound is propagating in a conical horn. And one point's SPL(sound pressure level), 5cm away from horn's apex, is 100dB. What is the peak particle velocity of the point? (Cone is assumed to be infinite)

8. Sound-absorbing material is installed in front of concrete wall. There is plane board with surface density of m(kg/m^2) ahead of the material. It is assumed that sound-absorbing material perfectly absorbs the sound energy while sound wave passes through the material. And it is also assumed that specific acoustic impedance of sound-absorbing material is 4 times larger than that of air. Plane wave vertically enters to the board. Answer the followings.

a) Plot the absorption coefficient of the whole structure (plane board + sound-absorbing material + concrete wall) as function of frequency. (15pts)

b) Determine the surface density m'(kg/m^2) when the absorption coefficient of the whole structure at 500Hz is half of the maximum absorption coefficient of the structure. (10pts)



PART III Practice problem

Note. Use computer program (excel, matlab, c+ etc.)

9. The table below shows some noise measurements of a small weapon in shooting range. The noise was measured for 2 seconds and its sample interval is 0.1s. Obtain the sound level (L_{Aeq}) during the measurement. (10pts)

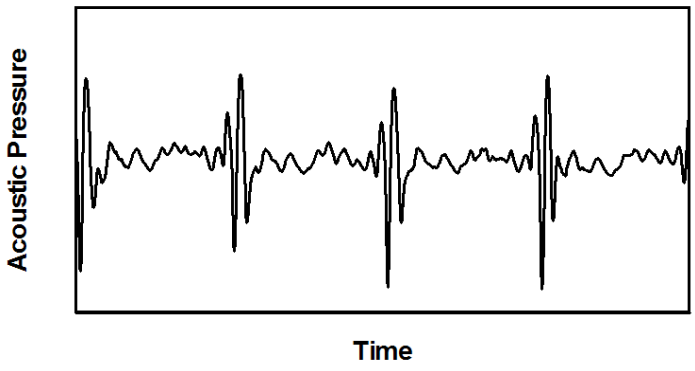
Time(s)	L_{Aeq}	Time(s)	L_{Aeq}	Time(s)	L_{Aeq}	Time(s)	L_{Aeq}
0.1	45.0	0.6	42.6	1.1	69.3	1.6	78.3
0.2	43.7	0.7	37.2	1.2	65.1	1.7	74.2
0.3	40.2	0.8	80.8	1.3	67.5	1.8	69.6
0.4	42.6	0.9	79.7	1.4	66.1	1.9	67.0
0.5	45.2	1.0	73.4	1.5	66.3	2.0	68.3

10. Noise from a helicopter rotor in BVI (blade-vortex interaction) operating condition was measured during one rotating period as shown in the figure below. When the sampling frequency was 40 kHz ($\Delta t = 2.5\times10^{-5}$ sec) (30pts)

a) Plot the narrow band frequency spectrum of this acoustic signal.

b) Obtain L_{eq} and L_{Aeq}.

c) Plot the octave band and 1/3 octave band frequency spectrums.



(# the raw data of acoustic pressure is attached to the homework file, aancl.snu.ac.kr)