Aeroacoustics & Noise Control Lab.
Dept. of Mechanical and Aerospace Engineering

Noise Engineering & Aeroacoustics **Class 2019_Spring**
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(TA : Jonghui Kim)

HomeWork #3 (Due 04/22)

1. Explain <u>briefly</u> the followings, (5pts each)

   a) Insertion and Transmission loss
   b) Sound propagation differences in day and night
   c) Evanescent wave

2. The following figure is the Rijke Tube creating a self-amplifying standing wave by using heat. This is an example of the Thermoacoustic-induced oscillation. (10pts each)

   a) Describe how the sound is generated by this tube with the heat source location.
      · Caution: The specific words should be included to get a score
   b) Calculate the solution of one dimensional wave equation and the fundamental frequency of this tube.
      · Assumptions: The sound is harmonic function. The medium in the tube is ideal gas. The temperature of the mesh increases from 20℃ (sound speed: $343m/s$) to 800℃, then the temperature in the tube will be uniformly 800℃.
   c) Derive the solution of one dimensional wave equation in case of one end closed.

3. An engineer wants to design a diverging rectangular duct with a design parameter Before experiment, the engineer wants to figure out the baseline of the design parameter of the duct in terms of acoustic sense. If the engineer assumes that the solution can be solved by wave equations with separable variables method, (15pts each)

a) Derive axial (x-directional) wavenumber k when θ is $\theta = 0$, $\theta = 45^\circ$ and $\theta = 60^\circ$, respectively.

   · Hint: $\frac{\partial f(z)}{\partial n} = n_x \frac{\partial f(z)}{\partial x} + n_z \frac{\partial f(z)}{\partial z} = 0$, $n = (n_x, n_z)$ is a normal vector of the upper wall

b) What are the cut-off frequencies of ducts for each parameter?

c) If you are the engineer, which parameter would you prefer and why?

4. When a ray travel through the continuously varying medium in divided 'n' slabs which have the reactive index ($n(\mathrm{x}) = 1 + ax$), derive the quadratic equation approximating the refracted path of the ray in the medium. (20pts)

· Assumption: $ax \ll 1$, and initial incidence angle is θ_0 at (0,0)

· Hint: $v_i = \frac{c}{n_i}$, when the light is incident to the medium having reactive index n_i. $(1 + \mathrm{x})^n \approx 1 + nx$ (when $x \ll 1$)

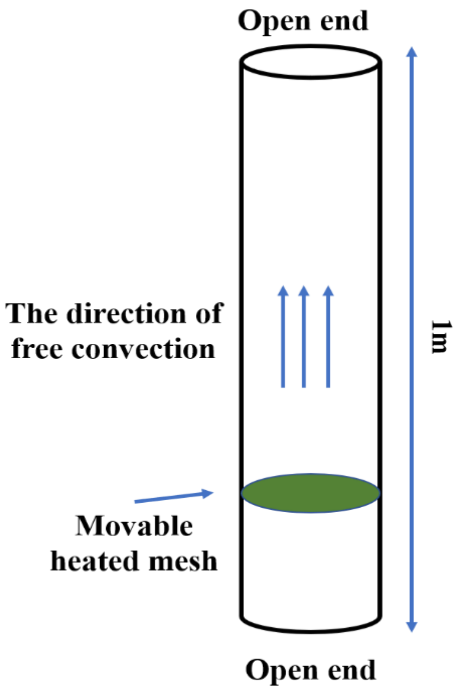

Figure of problem 2

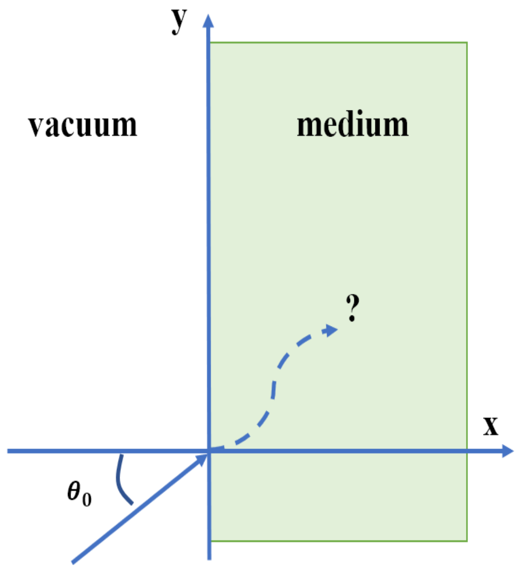

Figure of problem 4

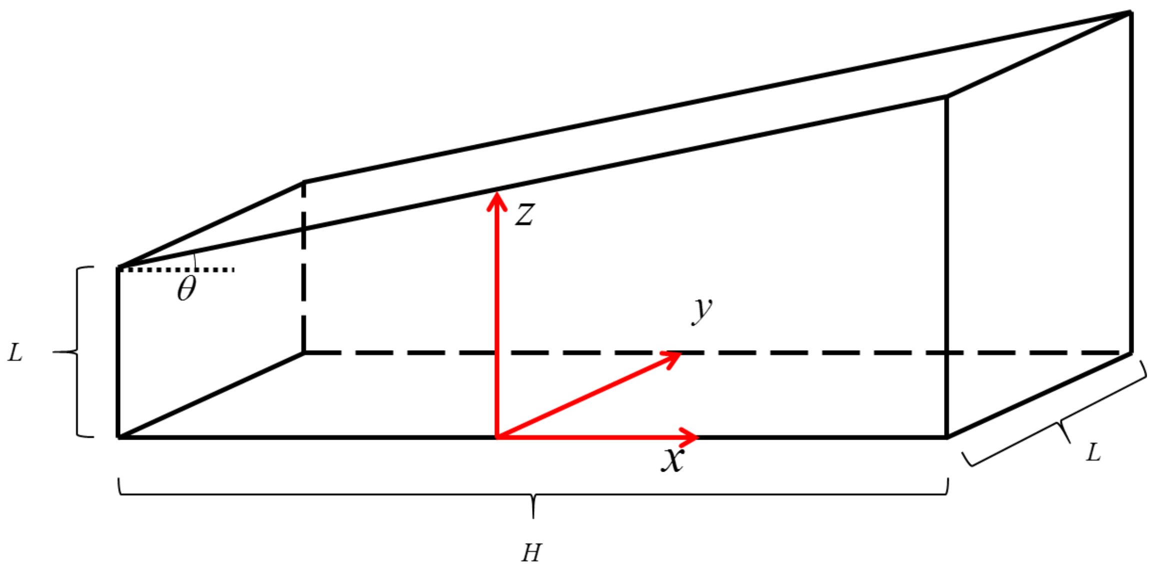

Figure of problem 3