Name: ______________________________

ME 513

Exam 1 – Fall 2006 --- 11/15/2006

Note: To help you complete this exam, you may refer to your class notes, your homework, solutions provided to you and other material distributed as part of the course, but you may not refer to the text (Kinsler, Frey, Coppens and Sanders) or to any other acoustics text

- Problem 1: ____________/20
- Problem 2: ____________/20
- Problem 3: ____________/20

Problem 1.

(i) What is sound?

(ii) The forced displacement of a SDOF oscillator can be written as:

$$x = Ae^{-j\omega t}$$

where A is complex. The _________________________ part of the solution corresponds to the physically measurable displacement.

(iii) What are the characteristics of a “mass-like” impedance?

(iv) A force $Fe^{-j\omega_1 t}$ is applied to a linear SDOF system having a natural frequency ω_0. At what frequency does the system respond?

(v) For a system to vibrate, it must possess ____ .

(vi) How does the addition of damping affect the natural frequency of a SDOF system?

(vii) The wave number is a measure of ____ .

(viii) The restoring force acting on a segment of a tensioned string is not proportional to the slope of the segment: instead, it is proportional to ____ .

(ix) What mistake did Newton make when he calculated the speed of sound in air?

(x) Why is convective acceleration considered to be negligible in the development of the wave equation?

Problem 2.

A unit amplitude transverse harmonic wave propagates in the positive-x direction along an infinite, uniform, tensioned string (the tension in the string is T_s and its mass per unit length is ρ_L) towards a simple mass, m, which is attached to the string at x=0.

(i) Give an appropriate assumed solution for the displacement fields on both sides of the mass.

(ii) Draw a free body diagram of the forces acting on the mass.

(iii) Give in equation form the boundary conditions that apply at $x = 0$.

(iv) Use the boundary conditions in conjunction with the assumed solution to solve for the transmission coefficient: i.e., find the complex amplitude of the wave that is transmitted past the mass.

(v) Sketch the magnitude of the transmission coefficient as a function of frequency, and answer the question: Is the mass effective at blocking the transmission of low or high frequency vibration?

Problem 3.

The spatial variation for the first non-planar mode in a two-dimensional hard-walled channel of width L is:

$$p(x, y) = A_1 \cos\left(\frac{\pi y}{L}\right) e^{-jk_1 x}$$

$$where: k_1 = \left[k^2 - \left(\frac{\pi}{L}\right)^2\right]^{\frac{1}{2}}$$

$k = \omega/c$ and A_1. is complex.

(i) Derive the vector particle velocity field by using the linearized momentum equation.

(ii) Calculate the vector intensity field in the channel, and show, in particular, that the y-component of the intensity is equal to zero.

(iii) Explain, based on your results, why the x-component of the intensity is also equal to zero when $k^2 < (\pi/L)^2$.