Homework set 2 – chapters 7—15 in Kinsler

Solutions will be provided for these problems around March 1

1. A plane wave at 1 kHz in water is normally incident on a concrete wall that can be considered as infinitely thick. (*a*) What is the standing wave ratio? (*b*) To what difference in pressure levels is this equivalent? (c) Where are the first three nodes located?

2. A square ventilating duct measures 0.3 m on each side. A Helmholtz resonator band filter is constructed by drilling a hole of 0.08 m radius in one wall of the duct leading into a surrounding closed chamber of volume V. (*a*) What volume V is required to filter sounds most effectively at 30 Hz? (*b*) What will be the power transmission coefficient of the filter at 60 Hz?

3. (*a*) Determine the loudness level and loudness of a 100 Hz tone with an intensity level of 60 dB *re* 10^{-12} W/m^2. (*b*) To what intensity level must this tone be reduced to lower its loudness to one-tenth of the value obtained in (*a*)? (*c*) To what intensity level must it be increased to raise its loudness to ten times the value determined in (*a*)?

4. Three pure tones have the following frequencies and values of L_l: 100 Hz at 60 dB, 200 Hz at 60 dB, and 500 Hz at 55 dB. (*a*) Which tone is the loudest? (*b*) What is the overall sound pressure level of these three tones when sounded simultaneously? (*c*) What is their total loudness level in phon?

5. The hourly average sound level for a community noise is 60 dBA from 7 A.M. to 7 P.M., 55 dBA from 7 P.M. to 10 P.M., and 50 dBA from 10 P.M. to 7 A.M. Find (*a*) L_{eq} for the 24 hours, (*b*) L_{dn}, and (*c*) *CNEL*.

6. Calculate the A-weighted sound pressure levels for an automobile and a motorcycle under cruising conditions measured at a distance of 15 m for speeds of 44 and 88 km/h.

7. If, at a given distance from a straight, two-lane road of infinite extent, zero grade, and negligible truck traffic, the maximum equivalent sound level is to remain constant, find the ratio of the maximum vehicle flow rate (Q) if the maximum speed is reduced from 104 km/h (65 mph) to 88 km/h (55 mph).

8. A 30 kHz sonar transducer produces an axial sound pressure level of 140 dB *re* 1 μPa at a distance of 1000 m in seawater. Assume spherical spreading and losses. (*a*) What is the axial pressure level at 1 km? (*b*) At 2000 m? (*c*) At what distance will the axial pressure level be reduced to 100 dB? (*d*) At what distance will *TL*(*geom*) equal *TL*(*losses*)? (*e*) At what distance is the rate of transmission loss associated with spherical divergence equal to that associated with absorption?

9. A sonar at 1 kHz has a source level of 220 dB *re* 1 μPa and receives an echo of level 110 dB *re* 1 μPa from a target at 1 km distance. Calculate the target strength.

10. A plane sinusoidal acoustic wave is normally incident onto a plane interface from air into a fluid of unknown acoustic impedance. If half the incident sound energy is reflected, what is the fluid's impedance? The characteristic impedance of air is $\rho_1 c_1 = (1.21\ \text{kg/m}^3)(343\ \text{m/s})$

11. A plane sinusoidal acoustic wave with f=1000 Hz and p=100 Pa in water is normally incident onto the flat surface of a lake [for fresh water, $\rho_2 c_2 = (998\ \text{kg/m}^3)(1481\ \text{m/s})$]. (a) find the acoustic p of the wave transmitted from water into air, (b) the intensity of the incident wave and of the transmitted wave in air, and (c) the ratio of intensity of the transmitted wave in air to the incident wave in water.

12. Two mono-frequency simple sources radiate diverging waves of equal amplitudes, uniformly in all directions. They are spaced a half-wavelength apart on the x-axis, and are in phase. Find the acoustic pressure p in the x-y plane at a distance $r >> \lambda$, at angles of 0, 45 and 90 deg from the x-axis (90 deg= y-axis), and use this to sketch the sound radiation pattern of the sources in the far field taking into account symmetries of the arrangement.

13. The loudness level of a 1000 Hz tone is 60 phons. (a) what is its loudness in sones? (b) how many such sources must be sounded to double its *loudness*? (c) how many would be needed to double its loudness *level ?*