Major exam (July-Nov 2016) MCL314: Acoustics and noise control

Max Time: Two hours

Max. Marks: 80

Note: Make suitable assumptions, if necessary, giving justification.

Q1. A) Find first three acoustic resonant frequencies of a room of size 8m×4m×5m. Sketch the corresponding mode shapes. B) Find the number of modes in the room in the 22-180 Hz frequency range. C) Define the term modal density. What is its significance for the analysis of sound in an enclosed space? (12)

Q2. Explain why noise control in the low frequency range using sound absorbing material is often not a feasible option in practice. (6)

Q3. What are weighting networks and when are they used? (4)

Q4. A) A Helmholtz resonator is to be constructed of a cylinder with the diameter equal to the length. The opening to the resonator is an orifice with a radius 10mm and a thickness 1mm. Find the resonator dimensions to use it to suppress a tonal noise of 250 Hz in a duct. The medium is air with density 1.2 kg/m3. Take sound speed as 343.8 m/s. B) Would the resonator designed in A) indeed respond like a Helmholtz resonator for the frequency in question? (8)

Q5. What are 1/1 and 1/3 octave filters? Why they are preferred in noise measurement and analysis over discrete or constant bandwidth filters? (6)

Q6. What is an extended-tube muffler? Explain how it helps in reducing the noise? (4)

Q7. What is diffused sound field? Under what conditions such a sound field exists? (4)

Q8. A) A cylindrical pipe of length L is driven by a source of constant volume velocity amplitude Q_0 at frequency f_0. The acoustic impedance is Z at the other end of the pipe. Assuming a 1-D wave propagation, obtain an expression for the acoustic pressure at an arbitrary point in the pipe. B) Using the result obtained in A) find the acoustic pressure if instead of having the impedance Z the end of the pipe i) is closed or ii) has an anechoic termination or iii) has a pressure release boundary condition. (12)

Q9. The height, width and length of a rectangular room are 3m, 4.6m and 9.1m respectively. It has a sound source of 10 microwatt located at the center of the edge between one of the 4.6m walls and the floor. The sound absorption coefficient α associated with the surfaces is: 0.02 for the walls, 0.1 for the floor and 0.26 for the ceiling. Find the SPL at the center of the room. (Take density of air as 1.21 kg/m3 and c=343m/sec). (6)

Q10. The interior surfaces of a rectangular auditorium have an average absorption coefficient of 0.3. The size of the auditorium is 30m × 50m × 15 m. What is its reverberation time? (4)

Q11. A rectangular acoustic barrier of size 6-ft-wide × 5-ft-high is proposed to be installed between a noisy pump and a receiver which are situated outdoor in a free field. The pump is located 1.5 ft above the floor, 2 ft directly behind the barrier and is symmetrical w.r.t to the barrier width. The receiver on the other side is also located symmetrical w.r.t to the barrier width and is 2 ft above the floor and is 4 ft away from the barrier. Determine the insertion loss of the barrier for the 1000-Hz octave band. (8)

Q12. A simple expansion chamber type reactive muffler is to be designed to obtain a peak transmission loss of 15 dB at a frequency of 125 Hz. Determine the length and the area-ratio of the expansion chamber. (6)