MCL 314 Acoustics and noise control

Major (July-Nov 2017)

Time: Two hours Max. Marks: 80

Note: Missing data, if any, may be suitably assumed, giving justification

Q1. A simple expansion chamber type reactive muffler is to be designed for reducing exhaust noise from an I.C. Engine. The noise generated has strong harmonics in the frequency range 136 Hz to 510 Hz. In view of this, the muffler is to be designed to have a transmission loss of at least 10 dB in this frequency range. The radius of the exhaust pipe and the tail pipe is 20 mm and the length of the expansion chamber is to be 300 mm. Determine the area-ratio of the expansion chamber to meet the above performance requirements. (c=343 m/sec) (7)

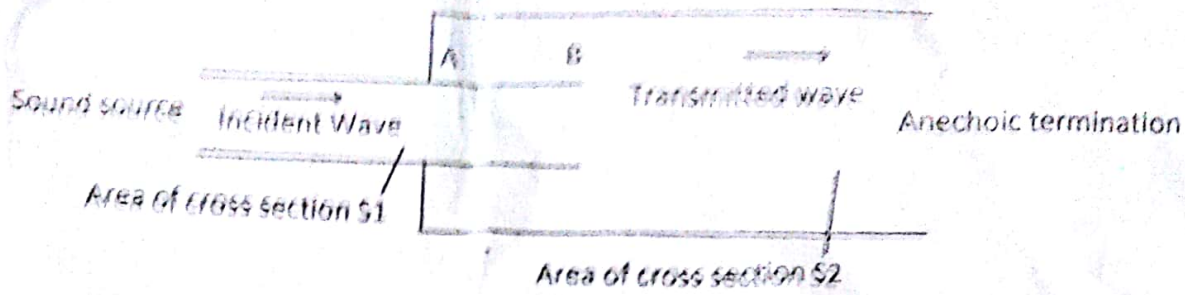
Q2. Find radiation impedance seen by end of pipe of diameter 10 cm open to atmosphere at frequencies 40Hz and 4000Hz. Comment on what the nature of the impedance in the two cases represent. (Take density and speed of sound in air as 1.21 kg/m3 and 343 m/sec respectively. (5)

Q3. The technical specification sheet of a condenser microphone is lost. In order to measure the sensitivity of the microphone, it is subjected to SPL of 90 dBA at 1000Hz. The output voltage is measured to be 1.0 millivolt. Find the sensitivity of the microphone. (5)

Q4. The sound pressure level spectrum around a wood chipper unit is given in Table below. Determine (a) the overall sound pressure level and (b) the A-weighted sound level for the chipper noise. (7)

Octave band center frequency, Hz	63	125	250	500	1,000	2,000	4,000	8,000
L_p(OB), dB	91	xx	99	xx	99	98	98	8x

Octave band center frequency, Hz	A-scale CFA
31.5	−39.4
63	−26.2
125	−16.1
250	−8.9
500	−3.2
1,000	0.0
2,000	+1.2
4,000	+1.0
8,000	−1.1
16,000	−6.6



Q6. During a 1-hour period, the A-weighted sound level is 70 dBA for 30 minutes, 75 dBA for 20 minutes, and 80 dBA for 10 minutes. Determine the energy equivalent sound level ($L_{eq.}$). (5)

Q7. Why noise source ranking is important in a noise control exercise when there are multiple sources of noise? (5)

Q8. Sate the equation for SPL at a point in an enclosed space due to a source inside it and explain on its basis the options available for noise control at points away from the walls, close to the source and at points close to the walls. (5)

Q9. How a barrier is different from an acoustic enclosure from the point of view of its application in noise control? (5)

Q10. For which noise frequencies a sound barrier is more effective: low freq. or high freq.? Explain with reason. (3)

Q11. What is an anechoic chamber? What is its application? (3)

Q12. What is the principle of noise control using a Helmholtz resonator? Sketch variation of its transmission loss versus frequency of the incident wave in a duct with a Helmholtz resonator attached on its wall. (5)

Q13. What is sound absorption coefficient? Write roughly its value for glass wool, concrete and open window. (5)

Q14. When do you need to analyze an acoustic system as a continuous system and when can you analyze it as a lumped parameter system? Explain and give examples. (3)

Q15. Is it feasible to use a wave or modal approach to analyze acoustics of, say, an auditorium? Justify your answer. (5)

Q16. A railway line is provided with a sufficiently long, 5m high acoustic barrier in order to give some acoustical protection to a parallel row of residential houses 50m away. The barrier is located 5m away from the centerline of the railway tracks. Assuming the source to be at a height of 1m from the ground, what would be the noise reduction at 250 Hz for a resident at a height of

a) 2m (ground floor) and b) 6m (first floor) (5)