TT3010 - Audio technology and room acoustics. Exercise 1

September 13, 2021

All tasks are reproduced from chapter 23 in "Science of Sound". Tasks marked *Mandatory* must be handed in for approval (online). Deadline is specified in blackboard.

Tasks

1. *Mandatory.* Using the Table 23.1, compare the absorption of 100m^2 of plastered wall with that of 100m^2 of a carpeted floor at

   a. 125Hz;

   b. 2000Hz.

2. *Mandatory.* An auditorium has dimensions 40m*20m and a ceiling height of 15m. The front and back walls are covered with plywood paneling; the side walls and ceiling are plaster. The floor is wood. There are 1100 upholstered seats. Estimate the reverberation time (at 500Hz) when

   a. The hall is empty;

   b. Half the seats are filled;

   c. All the the seats are occupied.

3. *Mandatory.* Estimate the time decay t1 of the first reflected sound for a person seated near the center of the auditorium described in Question 2. Does the first reflection arrive from the side or from overhead ?

4. If the ceiling in the auditorium were covered with acoustical tile, by how much would the reverberation time be decreased ?

5. *Mandatory.* Specify reasonable values for the reverberation times at 100, 200 and 1000Hz for a 2000m^3 concert hall to be used primarily for orchestral music.

6. *Mandatory.* If two hard parallel walls are spaced 30m apart, calculate the repetition rate of the flutter echo that might result. What efforts might be made to prevent its occurence ?

7. Find the reverberation time at 8000Hz for a very live room having a volume of 1000m^3 when the temperature is 20°C and the relative humidity is 30%. Assume that absorption by the walls is negligibly small. Would your answer be different if V = 100m^3 instead ?

TABLE 23.1 Absorption coefficients for various materials

Material	Frequency (Hz) 125	250	500	1000	2000	4000
Concrete block, unpainted	0.36	0.44	0.31	0.29	0.39	0.25
Concrete block, painted	0.10	0.05	0.06	0.07	0.09	0.08
Glass, window	0.35	0.25	0.18	0.12	0.07	0.04
Plaster on lath	0.14	0.10	0.06	0.05	0.04	0.03
Plywood paneling	0.28	0.22	0.17	0.09	0.10	0.11
Drapery, lightweight	0.03	0.04	0.11	0.17	0.24	0.35
Drapery, heavyweight	0.14	0.35	0.55	0.72	0.70	0.65
Terrazzo floor	0.01	0.01	0.02	0.02	0.02	0.02
Wood floor	0.15	0.11	0.10	0.07	0.06	0.07
Carpet, on concrete	0.02	0.06	0.14	0.37	0.60	0.65
Carpet, on pad	0.08	0.24	0.57	0.69	0.71	0.73
Acoustical tile, suspended	0.76	0.93	0.83	0.99	0.99	0.94
Acoustical tile, on concrete	0.14	0.20	0.76	0.79	0.58	0.37
Gypsum board, $\frac{1}{2}$ in.	0.29	0.10	0.05	0.04	0.07	0.09

Figure 1: Retrieved from Rossing chap 23.

TABLE 23.2 Sound absorption by people and seats, and air absorption

Material	Frequency (Hz) 125	250	500	1000	2000	4000	8000	Unit*
Wood or metal seats, unoccupied	0.014	0.018	0.020	0.036	0.035	0.028		m^2
Upholstered seats, unoccupied	0.13	0.26	0.39	0.46	0.43	0.41		m^2
Audience in upholstered seats	0.27	0.40	0.56	0.65	0.64	0.56		m^2
Air absorption (per m^3):								
20°C, 30%	—	—	—	—	0.012	0.038	0.136	m^{-1}
20°C, 50%	—	—	—	—	0.010	0.024	0.086	m^{-1}

Note: Values of sound absorption are given in m^2; to convert to ft^2, multiply by 10.8. Values of air absorption are given in m^{-1}; to convert to ft^{-1}, divide by 3.3.

Figure 2: Retrieved from Rossing chap 23.

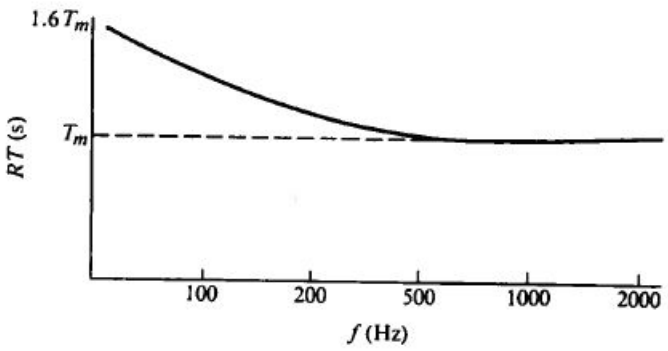

FIGURE 23.8
Variation of reverberation time with frequency in a good concert hall.

Figure 3: Retrieved from Rossing chap 23.

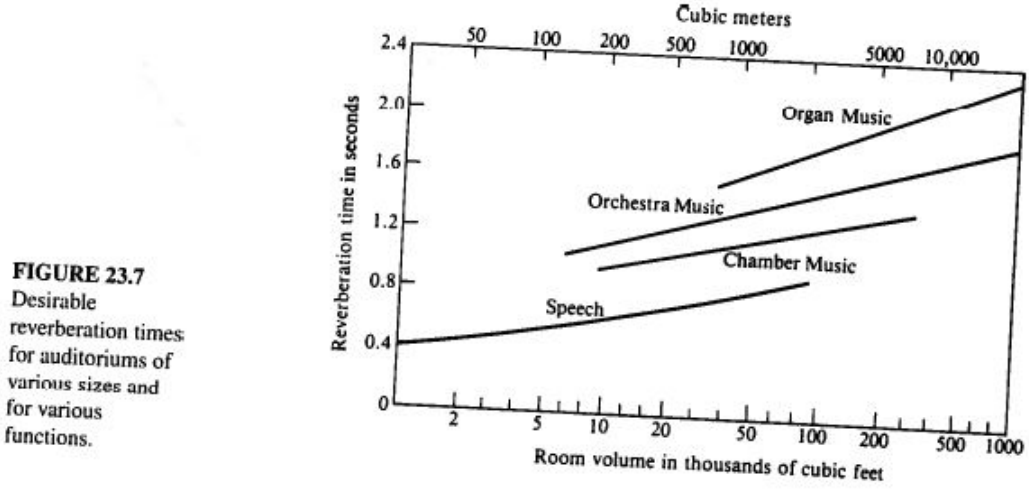

FIGURE 23.7
Desirable reverberation times for auditoriums of various sizes and for various functions.

Figure 4: Retrieved from Rossing chap 23.