Architectural Acoustics

Exercises Q&A week 7

Room Acoustics

27-03-2020

Question 1

The dimensions of a small room are: L = 7 m, W = 6 m , H = 3 m. The reverberation time T is 1s.

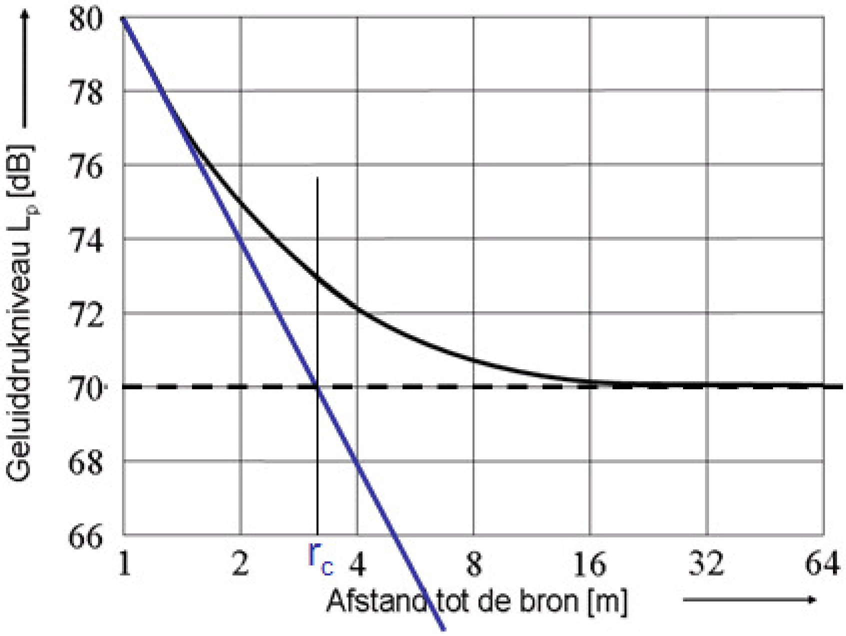
a) What is the Schroeder frequency? 178 Hz
b) What is the lowest axial eigenfrequency? 24,5 Hz
c) What is the lowest tangential eigenfrequency? 37,7 Hz
d) What is the lowest obligue eigenfrequency? 68,5 Hz

Question 2

a) Describe the difference between 'near field' and 'far field'. Near field: no spherical sound propagation (in direct field), large sound source dimension in relation to distance to sound source, less than -6 dB/2r. Far field: spherical sound propagation (small sound source dimensions: point source), -6dB/2r (in direct field)
b) Describe the difference between 'diffuse field' and 'direct field'. Direct: blue line fig. question 3, diffuse: dashed line fig. question 3
c) What is the definition of reverberation time in terms of level [dB] and time [s]? Decay time over 60 dB
d) What is the difference between T_{20} and T_{30}? Interval: $T_{20} = 3*(t_{-5..-25\,dB})$, $T_{30} = 3*(t_{-5..-35\,dB})$

Question 3

The graph below shows the result of a sound pressure level measurement in a hall using a small omnidirectional sound source (Q = 1).



Translation: Geluiddrukniveau = Sound Pressure Level
Afstand tot de bron = Sound-Receiver-distance

a) What is the diffuse field sound pressure level (Lp_{diff})? 70 dB

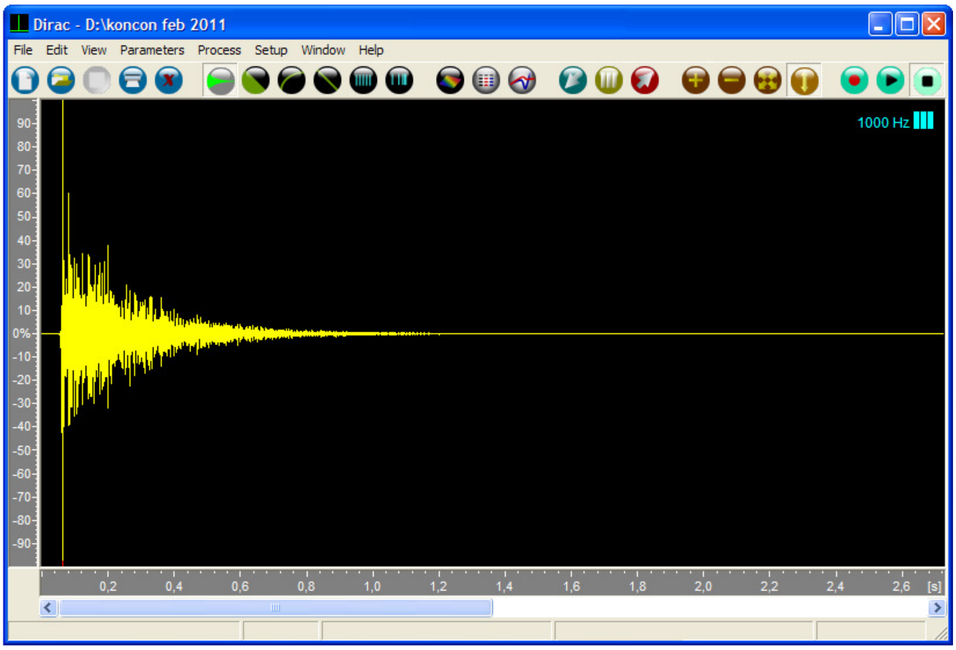
b) What is the sound power level of the sound source (L_W)? $L_p = L_w + 10\log(Q/4\pi r^2)$,
$80 = L_w + 10\log(1/4\pi)$, $L_w = 80 + 11 = 91$ dB

c) What is the critical distance r_c (galmstraal r_k)? Approx. 3 m: distance where $L_p = 73$ ('70+70=73'), distance at crosspoint diffuse field line and direct field line

d) Draw (in the same graph) the sound pressure level line for the same sound source in a free field (for instance: anechoic room: room with 100% sound absorption) Blue line (6dB/2r)

Question 4

The picture below shows the result of one acoustical measurement. It is the 1kHz octave band sound pressure graph p(t).



Screen dump: sound pressure graph.

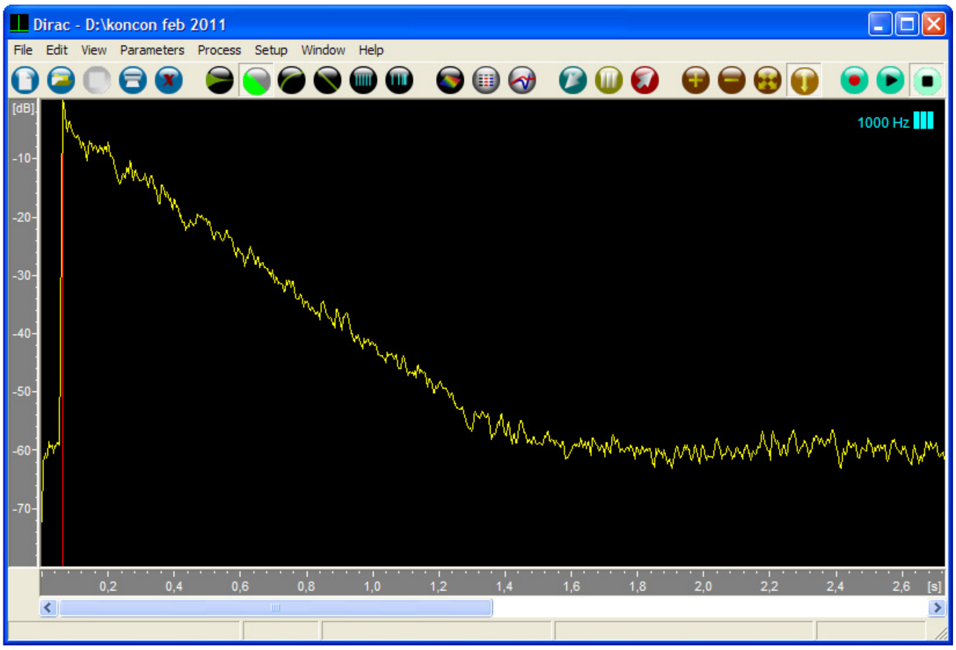
a) How is this sound pressure graph called? Impulse response IR (or room impulse response RIR)

b) How can you obtain this graph? Recording of a gun shot, popping balloon or hand clap

c) Mention an example of a typical room acoustical parameter to assess music transfer and a typical parameter to assess speech transfer? C_{80} [dB] for music, D_{50} [-] (and Speech Transmission Index: STI [-]) for speech

Question 5

The picture below is derived from the pressure graph (see Question 4). It is called the Energy-Time-Curve (ETC).



Screen dump: Energy-Time-Curve

a) How can you derive this graph from a pressure graph? $10*\log(p^2)$
b) What is the first peak in the graph (at position of the red line)? Direct sound (first arrival)
c) What is the decay range in dB of this measurement?
d) How can you increase the decay range of an ETC? Increasing signal- and/or decreasing background noise level
e) What is the reverberation time (no definition; a value please)? Explain/discuss! From 0 dB to -60 dB: 1,4 s - 0,04 s = 1.36 s approx. 1,4 s

Question 6

Which statement is not correct? The Q-factor of a (loud)speaker box

1 is equal to $10^{\frac{q}{10}}$ and can have a value less than 1
2 depends on the listening direction
3 can have a value less than 1 and depends on frequency
4 is expressed in dB