Urban Physics, 7S0X0

Urban Acoustics, Exercises week 1&2

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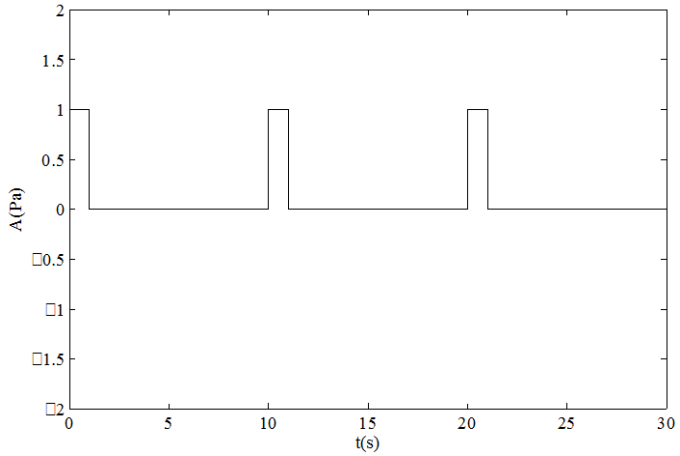
1) Environmental noise may cause various health effects. Explain whether equivalent noise levels below 50 dB(A) can affect health.

2) Explain why noise maps according to the European Noise Directive are currently produced by calculations rather than by using measurement results.

3) For what adverse health effects is the L_{den} indicator a good metric?



4) An emergency signal has a periodicity of 10 s and can be described as

$$p(t) = A\,sin(\omega t)$$

with

$$A = \begin{cases} 1 & \text{for } 0 < t < 1 \\ 0 & \text{for } 1 < t < 10 \end{cases}$$

with t the time, $\omega = 2\pi f$ the angular frequency, f = 1000 Hz, and A = 1 Pa the amplitude of the signal. In Figure 1, the amplitude is shown as a function of time.

Figure 1. Signal amplitude as function of time.

a) What is the equivalent sound pressure level $L_{eq,T}$ of this signal when averaging over the first 5 s of this signal, i.e. T = 5 s? (hint $\int_0^1 p(t)^2\,dt = \frac{A^2}{2}$)

b) What is $L_{eq,T}$ with T = 100 s? Why is this value lower or higher than the result of 4a)?

5) Two friends have their student flat along different roads of the city. Both are annoyed by road traffic noise at home. They are curious who of them suffers from the highest noise level. They decide to measure the equivalent sound pressure level in the open window of each of their flat, in $L_{eq,j}$ (dB), with j the octave band index. The results are listed in Table 1. We can consider the level to be the level incident to the facade of their flat. For comparing their results, they decided to compare the single number equivalent level by energetically add the levels of all octave bands.

Table 1. Measured $L_{eq,j}$ at the facades of the student flats of Erik and Martijn.

Octave band middle frequency (Hz)	$L_{pj,eq}$ Erik (dB)	$L_{pj,eq}$ Martijn (dB)
63	52	56
125	49	53
250	52	52
500	51	51
1000	56	53
2000	49	46
4000	40	37
8000	35	32

a) Compute the level L_{eq} (dB) at the facades of the student apartments of Erik and Martijn.
b) Who has the highest level when computing L_{Aeq} (dB(A)), i.e. taking into account A-weighting in the calculations?
c) Finally, Erik notices that his measurement took 30 minutes while Martijn only has measured for a period of 10 minutes. What correction should we apply to the measured levels to compared them in a fair way?

6) The yearly averaged sound pressure levels due to noise from road traffic L_{day}, $L_{evening}$ and L_{night}, should be computed at the facade of a hospital. Table 2 shows the hourly averaged values.

Table 2. Hourly averaged equivalent sound pressure levels at the facade of the hospital.

Hour	L_{Aeq} (dB(A))	*Hour*	L_{Aeq} (dB(A))	*Hour*	L_{Aeq} (dB(A))
0-1	44	8-9	72	16-17	68
1-2	42	9-10	70	17-18	72
2-3	42	10-11	65	18-19	62
3-4	43	11-12	65	19-20	55
4-5	46	12-13	68	20-21	53
5-6	55	13-14	63	21-22	50
6-7	68	14-15	62	22-23	48
7-8	70	15-16	63	22-24	44

a) Compute L_{day}, $L_{evening}$ and L_{night} from Table 2.
b) Compute L_{den}.