

Acoustics exercise session of October 11, 2019 - Questions

Exercise 1

Demonstrate (on paper) that

$$p(x, t) = f(x - ct) \quad (1)$$

is a solution of the partial differential equation :

$$\frac{\partial^2 p}{\partial x^2} - \frac{1}{c^2} \frac{\partial^2 p}{\partial t^2} = 0 \quad (2)$$

Exercise 2

Viewers in a movie theater are located 15 meters away from the screen and from the loudspeaker broadcasting the soundtrack. Assuming the film features 24 frames per second, by how many frames should the sound and image tracks be shifted with respect to one another to ensure a correct synchronisation of sound and image by the viewers ?

Exercise 3

Make a rough sketch (on paper) of the noise spectrum associated with the two fans of Fig.3. They both rotate at 1200rpm.

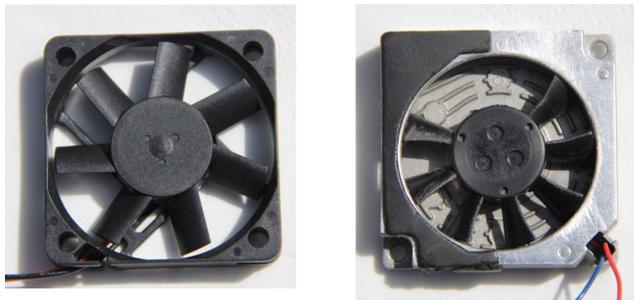


FIGURE 1 : Two fans.

Exercise 4

The pressure inside a tyre is of 2.2bar. What is the speed of sound and air density in the tyre at 20°C ($c_p = 1004.5$, $c_v = 717.5$ J/(kg.K)) ?

Exercise 5

A harmonic sound has four components : the fundamental at 100Hz and the first, second and third harmonic. The complex amplitudes D of the four components of the pressure signal are respectively $(4+i)$, $(2-i)$, 1 and i . Give each component's amplitude and phase. For each component, give the value of f , T , ω , k and λ for air at 60°C . Write, on paper, a complete expression of the corresponding signal. What is the period of the harmonic sound (sum of the four components)? Plot the time variation of the pressure signal using MATLAB.

Exercise 6

A harmonic sound has three components : the fundamental at 200Hz and the first and second harmonic. The complex amplitudes of the three components of the pressure signal are respectively $(4+i)$, $(2-i)$ and 1 . The complex amplitudes of the three components of the acoustic velocity signal are respectively i , $(1+i)$ and $(1-i)$. What is the value of the active intensity? Confirm by a dimensional analysis that intensity, which is defined as pressure times velocity has indeed the units of power per unit area.

Exercise 7

Calculate the acoustic level resulting from the combination of five sources whose levels are respectively 60, 55, 50, 48 and 47 dB. You can use MATLAB or your calculator to do the calculation ; you may also try to get an approximate value using the abacus of Fig.2.

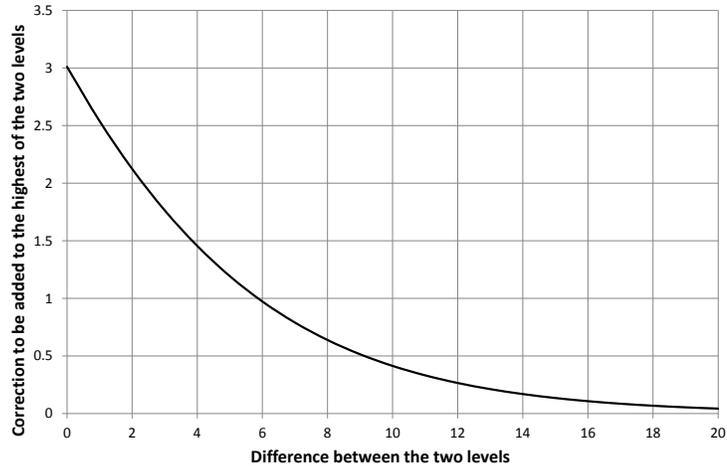


FIGURE 2 : Level sum correction abacus.