

# Assignment

## Homework HL2

Master program in Music and Acoustic Engineering

Musical Acoustics

course code: 051483

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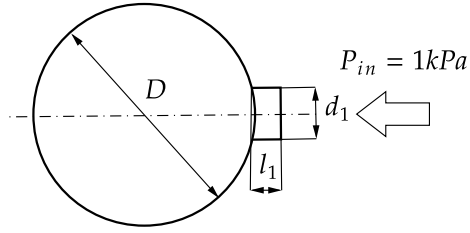
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Academic year 2023/2024



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MILANO 1863

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### Problem

#### Design and Analysis of Spherical Helmholtz Resonators

- a) Design your resonator: exploiting the analytic formulation of the relation between frequency and geometry, define the diameter  $D$  of a spherical Helmholtz resonator with resonance frequency at  $f_1 = 300$  Hz in air, consider  $d_1 = 4$ [cm]  $l_1 = 1$ [cm]. (5 points)

Build the model in COMSOL considering the viscous gas condition in 2D axial symmetric environment.

- b) Create the proper mesh to perform a frequency sweep analysis of the input impedance from 10Hz to 10kHz with 10Hz steps. (5 points)
- c) Perform the same analysis by varying  $d_1 = [1, 3, 8]$ [cm] and comment the results. (5 points)
- d) Perform the modal analysis for  $m = 0, 1, 2, 3$  and show the influence of the high modes on the impedance, then choose the "better" resonator (with less resonance in the studied frequency range among those simulated) (10 points)

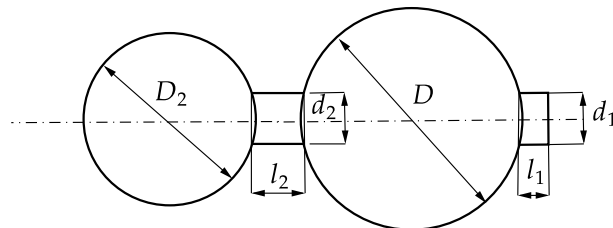


Figure 1: Example of the system

### Problem

Now consider another resonator coupled at the closed end of the previous one with  $D_2 = 15.86\text{cm}$ ,  $d_2 = 4\text{cm}$  and  $l_2 = 2l_1$  (see Fig 1)

- e) Implement the new configuration in COMSOL and perform the viscous simulation from 10Hz to 10kHz. (5 points)
- f) Set the electric analog of the system in Simscape and plot the frequency response (10 points)
- g) Compare and comment the results (10 points)

**Provide the solution by Dec. 4, 2023, using the WeBeep assignment tool.**

- The report must fit in 10 pages of the Latex template available at <https://www.overleaf.com/read/rnkchgybrrsm>;
- Answer concisely;
- Describe – concisely - the procedure used to obtain the results: if an error is present, I cannot identify the reason – numerical or conceptual - if the procedure is not described: in grading I will be forced to use the worst-case option.
- All students who participated to the same group must upload the report;
- In the PDF file and in the filename, specify the name, surname and ID of all the students participating to the HW, if more than one student worked on it.
- Also please provide the MATLAB and COMSOL files related to each of the exercises