Exercise 8: Eigenvalue Problem for 2D Acoustic Domain

We consider a two-dimensional domain consisting of a rectangular room, 4 m x 10 m. All sides are rigid. Solve the eigenvalue problem for this room model.

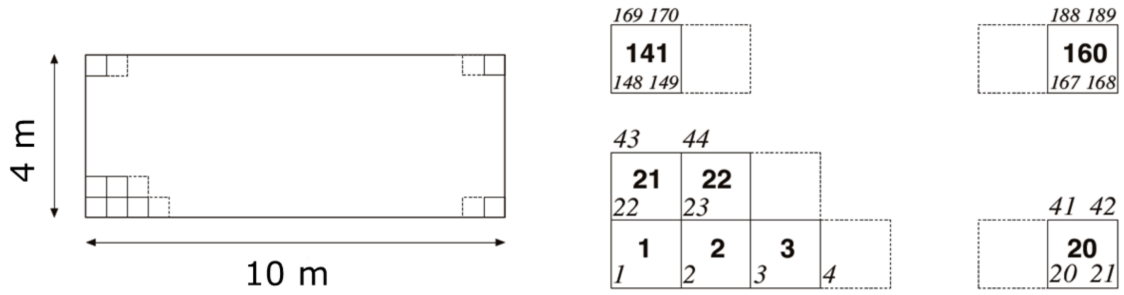

Figure 1 – The finite element mesh of the room model including numbering. (CalFEM by G. Sandberg, P.-A. Wernberg and P. Davidsson)

Download the basic MatLab scripts from the corresponding section in DTU learn. They consist of the following files:

- `FEM_ex8_1_Run_2D_Eig.m`: Main code for this exercise (You need to complete this script)
- `FEM_ex8_1_MeshInfo.mat`: Including mesh information `[ex, ey, edof]`.
- `FEM_ex8_1_DrawElementTopology.m`: Plot FE mesh
- `FEM_ex8_1_AcoQ4.m`: Script for element matrix. (You need to complete this script)
- `FEM_ex8_1_Extract.m`: Extract element pressure.

- `FEM_ex8_2_PDEtool.m`: Introduction to FEM using the MatLab PDE toolbox.

8.1 Implementation of Two-Dimensional FEM Code

The script `FEM_ex8_1_Run_2D_Eig.m` contain the basics pre- and post-processing steps. However, the FEM assembly steps of `FEM_ex8_1_Run_2D_Eig.m` and `FEM_ex8_1_AcoQ4.m` are missing. Specifically the following tasks need to be filled:

a) Write code for the Jacobian determinant.

b) Write code for the **B** matrix: derivative of the shape functions with respect to local coordinates.

c) Construction of the element stiffness matrix and mass matrix.

d) Construction of the global stiffness matrix and mass matrix.

While `FEM_ex8_1_Run_2D_Eig.m` already contains the eigenvalue analysis, I suggest that you spend some time actually understanding what it does.

8.2 Comparing Results

Compare your results with the MatLab PDE toolbox FEM implementation in `FEM_ex8_2_PDEtool.m` and an analytical calculation of room modes. Understand the code (optional: perform a convergence study using the PDE toolbox FEM implementation).