Exercise 2 – Matlab

Exercises deal with forced vibrations and frequency responses. The exercises cover both the direct and the modal superposition methods.

Exercise 2.1: Forced response - direct method

Modify your code such that it can perform an undamped forced vibration analysis. To do this you should add a new analysis type, e.g. `freq_direct`, to 'FEM/Solver.m' and add parameter `omega` to the study struct, i.e. `study.omega`. Use this variable to store the range of frequencies to be included in the frequency response. Solve $a \times b \times h$ simply supported rectangular plate problem with a point load at $(1/4a,\ 1/4b)$ (you will need to change the loading in the mesh struct yourself!) for a range of frequencies, e.g. corresponding to the first 10 natural frequencies. Plot the vertical response of the loaded node as a function of frequency. Compare the result to an eigenvalue analysis and explain the results.

HINT: In the frequency response it is sometimes most illustrative to plot the logarithm of the magnitude of the displacement.

Exercise 2.2: Forced response - modal superposition

Implement modal superposition as an alternative to the direct forced response. I.e. add a new analysis type, e.g. `freq_modal`, to 'FEM/Solver.m'. Use the plate problem from Exercise 2.1 and comment on how the response compares to the direct solution approach. Investigate the influence of the number of modes used in the modal expansion.

Exercise 2.3: Forced response - modal acceleration

Add the possibility to perform modal superposition with a static correction term to your code, i.e. the modal acceleration method. That is, add a new analysis type,e.g. `freq_modal_acc`, to 'FEM/Solver.m'. Compare the results (i.e. accuracy, number of used modes) of the standard modal superposition method to the modal acceleration and comment on your findings.

Exercise 2.4: Different excitation

Investigate the influence of the load location for a forced response using both modal and direct methods. For example consider a rectangular plate of dimensions $a \times b \times h$; what happens to the accuracy of the modal frequency response when the point load is in the center or very close to a boundary (e.g. $(1/3a$, $1/3b)$). Plot both the vertical response of the loaded node and the total response (e.g. as $\log(\{D\}^T\{D\})$). Compare the results from both the direct and the modal approaches.

*Exercise 2.5: Performance of the direct and the modal method

Compare the performance in wall clock time for the direct and the modal superposition methods for obtaining the frequency response.
HINT: Use the Matlab timing methods '`tic`' and '`toc`' to time the analysis.

*Exercise 2.6: Frequency range refinement

Perform a frequency discretization study and explain what happens to the magnitude of the amplitude as the frequency interval is refined.

*Exercise 2.7: Anti resonances

Examine possible anti-resonances by tracking the vertical displacement of the loaded node for different point load positions. Compare responses made by the direct and the modal superposition methods and comment on the results.