Violin modeling

Master program in Music and Acoustic Engineering

Musical Acoustics, course code: 051483

Project 1

Academic year 2025/2026

POLITECNICO
MILANO 1863

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Problem

Violin, from modeling to sound synthesis

a) Our goal is to study the vibrational behavior of a violin. We start from a simplified model, where the soundboard is a circular flat plate, whose radius is $a = 13.15$ cm and the thickness $h = 4$ mm. The plate is made by an isotropic material, with the Young modulus E equivalent to that of the Sitka spruce along the longitudinal dimension, the Poisson coefficient $\nu = 0.32$ and the density $\rho = 400 kg/m^3$. Compute the eigenfrequencies of the first five modes under the free edge boundary condition.

b) The plate is now arched to form a shell. The depth of the spherical cap shell is $H = 15mm$. Predict the eigenfrequency of the lowest mode of the shell, using the theoretical equations.

c) Setup a Comsol simulation to study the vibrational behaviour of the violin: import the violin model into Comsol, model a simplified geometry for the bridge, add the structural mechanics module and free boundary condition. The material is now assumed to orthotropic, and it is Sitka Spruce with the grain directed along the longer direction while the radial direction corresponds to the shorter one.

d) Run an eigenfrequency study and plot the first five modeshapes, for both the top and back plates.

e) Evaluate the mobility trying to replicate the same excitation/measurement position as done for the measurements taken during the lab session.

f) Extract the FRF and the coherence from the data measured during the lab session. Determine the frequency range for which the measurement can be considered valid and trim the FRF accordingly.

g) Using simulink: Build a filterbank model fitting the peaks of the simulated mobility. Build a filterbank model fitting the peaks of the measured mobility.

h) Define an excitation signal using a Karplus-Strong algorithm. Feed the signal to the two filterbanks. Plot and compare the results in the frequency domain.

Provide the solution 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;**
- **Upload the COMSOL file saving it without results;**
- **Upload matlab code(s) and simulink model(s);**
- **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.**