Assignment

Part 1 – Circular membrane characterization

It is given a circular membrane with radius 0.2 m, and tension 10 N/m. The unit surface weight is σ=0.1 kg/m^2.

a) Compute the propagation speed in the membrane.

b) Compute the frequency of the first five modes for this membrane and draw in Matlab the corresponding modeshapes.

Part 2 – Circular plate characterization

Consider now a thin plate with clamped edges and with the same size of the membrane. The plate has a thickness of 1 mm, and it is made with aluminum (E=69 GPa, ρ=2700 kg/m^3, ν=0.334).

c) Compute the propagation speed of quasi-longitudinal and longitudinal waves;

d) plot the propagation speed of the bending waves as a function of the frequency for the considered plate;

e) find the modal frequencies of the first five bending modes of the plate.

f) plot the modeshape displacement of the first five bending modes (note: the equation for the modeshape is not given in the slides, but everything is there for deriving it).

Part 3 – Interaction between coupled systems

Consider now that a string is attached to the considered plate, and its fundamental mode is tuned to the frequency of the first mode of the plate. The string is made with iron (ρ=5000 kg/m^3), its cross section is circular with a radius of 0.001 m, and its length is L=0.4m.

Due to internal losses and sound radiation, the plate at the frequency of the considered mode dissipates energy, and the merit factor is 50.

g) Compute the tension of the string so that its fundamental mode is tuned with the first mode of the soundboard.

h) Compute (looking up the plot provided in the slides) the frequencies of the modes of the string-soundboard system resulting from their coupling.