Dynamics of Structures 2016–17, 2nd homework

This homework is strictly optional. If you want it corrected please hand in a manuscript or printed copy on Thursday April 20th, after the class.

For problems 1 & 2 describe with sufficient detail the procedures you followed and the intermediate results that led to your answers, especially the analytical expressions of the modal responses. No written report is required for problem 3, see below for further instructions.

1 3 DOF System

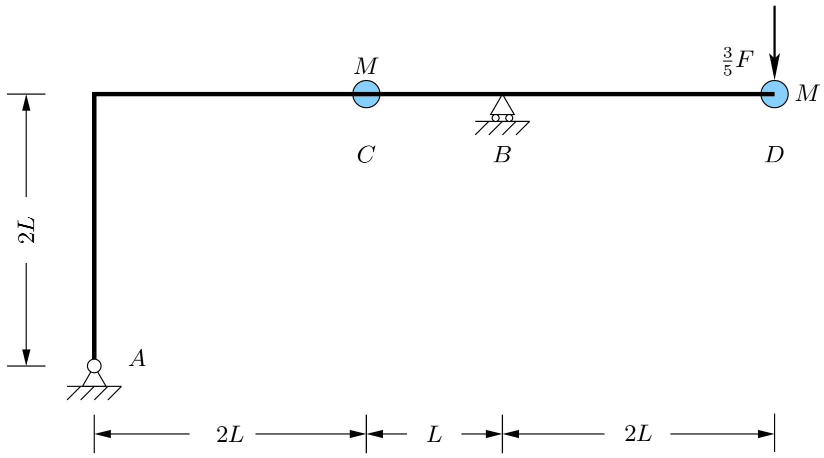

Figure 1: the system at time $t = 0^-$.

The structure in figure 1 is composed of a single, uniform beam whose mass is negligible with respect to the masses M of the two identical bodies that the beam supports; the axial and shear deformabilities of the beam are negligible with respect to its flexural deformability, characterized by the flexural stiffness EJ.

The system is in a condition of static equilibrium under an external load applied in D (hence deformed) but at $t = 0$ the external load is suddenly removed.

Plot the value of the reaction R_B for $0 \le t \le 20t_0$, where $t_0 = 2\pi\sqrt{\frac{ML^3}{EJ}}$

2 Static Condensation

The structure in figure 2 is the same structure of problem 1 (except that there is no static load acting on it for $t < 0$) and it is at rest when it is loaded by a vertical force applied in E.

$$P_E(t) = 3F \begin{cases} \sin(\pi t/t_0) & 0 \le t \le t_0 \\ 0 & \text{otherwise} \end{cases}.$$

Plot the modal response $q_1(t)$ and the vertical displacement of the point D in the time interval $0 \le t \le 20t_0$, using the position $\delta = FL^3/EJ$.

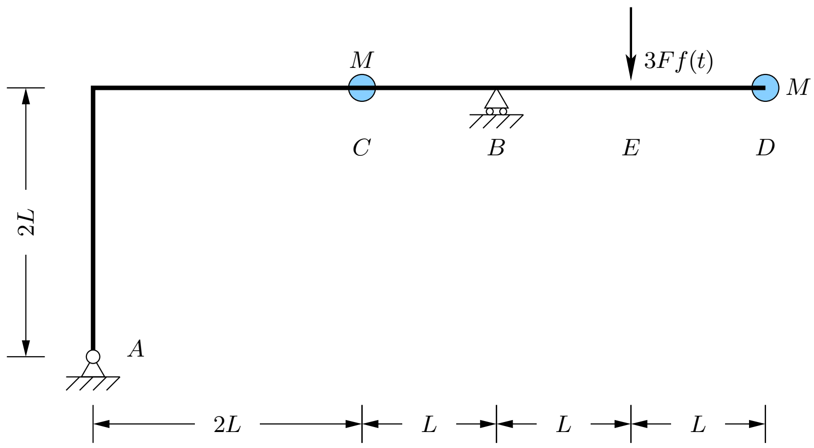

Figure 2: dynamic system with external loading.

3 Eigenvalues of a FEM Model

In the course page (boffi.github.io) I have posted links to compressed files describing the stiffness and mass matrices from a FEM model of a transmission tower. The units of the two matrices are unspecified but you know that $\boldsymbol{M}^{-1}\boldsymbol{K}$ is, dimensionally speaking, a matrix of squared circular frequencies.

- Download and decompress the two files on your computer.
- Write a computer program that
  - reads the two files,
  - populates the structural matrices according to the descriptions the files contain,
  - generates a base Φ_0 of 20 random vectors,
  - performs 5 times the Subspace Iteration procedure,
  - prints a simple 12x5 table describing the evolution of the approximations to the lowest 12 eigenvectors, e.g.

	1	2	3	4	5
ω_1^2	...	...	...	...	...
ω_2^2	...	...	...	...	...
...	...	...	...	...	...
ω_{12}^2	...	...	...	...	...

    (header row and row denominations are not required).
- Mail said program to me (giacomo.boffi@polimi.it).

Note that the only output produced by your program must be the table with the evolution of the eigenvalues.