Mechanical Systems Dynamics 2015
Exam Simulation

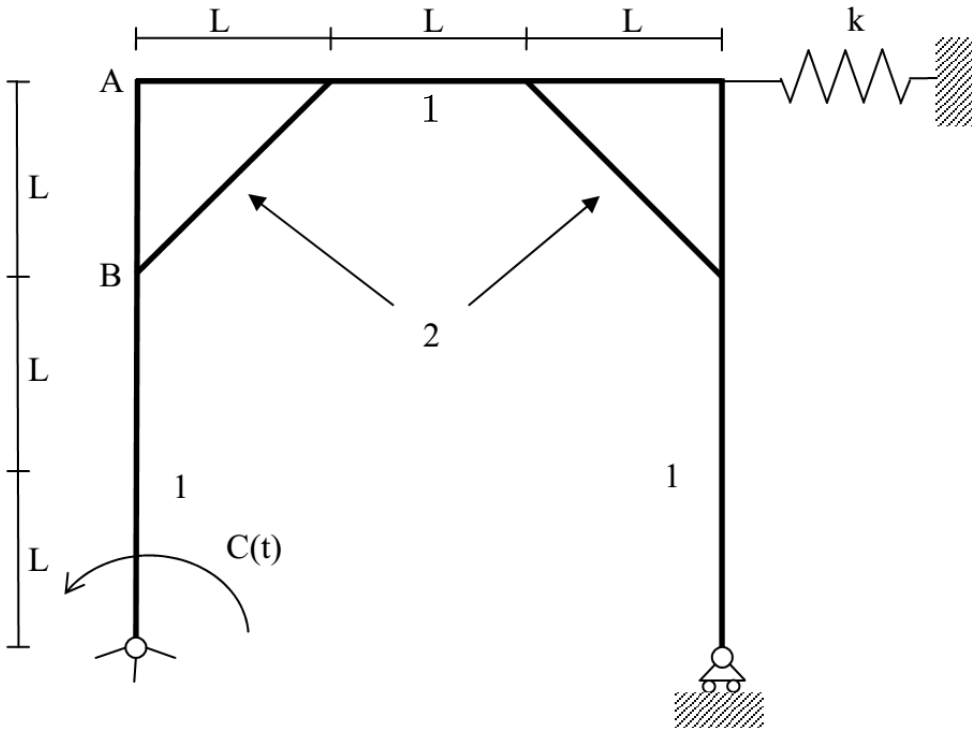


Figure 1: Structure

1. Build a FEM model for the structure depicted in Fig.1, reliable in the frequency range $0 - 300$ Hz. Refer to the structural properties reported in Tab.1, Fig.2 and Fig.3.

2. Compute the first 5 natural frequencies and mode shapes.

3. Assuming a Rayleigh model for damping, say $[C] = \alpha[M] + \beta[K]$, find the coefficients α and β such that the damping ratio best fits 1% for the first 4 modes.

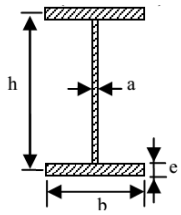
4. Compute the frequency response function, by a resolution of 0.1 Hz, in the band $0 - 300$ Hz, of the horizontal displacements of A and B, due to the torque $C(t)$.

5. Replace the connecting rodes (Fig.3) by concentrated springs of stiffness $K_c = 1e5$ N/m. Then, compute the first three natural frequencies and mode shapes. Which is the stiffness of the springs such that the first three natural frequencies are not affected by this change in the structure?

6. Assuming that the external torque $C(t)$ has the periodic form reported in Fig.4, with a period $T = 3s$ and $C_{max} = 500$ Nm, compute the *steady-state response* of the horizontal displacement A, neglecting any contribution of the external load for harmonics higher than the third.

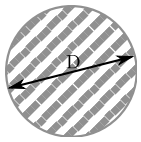
E[N/m^2]	ρ [kg/m^3]	k [N/m]	L [m]
2.06e11	7800	1e6	0.5

Table 1: Structural properties



Section	h [mm]	b [mm]	a [mm]	e [mm]	A [cm^2]	J [cm^4]
1	160	82	5	7.4	20.1	869

Figure 2: Section 1



Section	D [mm]
2	20

Figure 3: Section 2

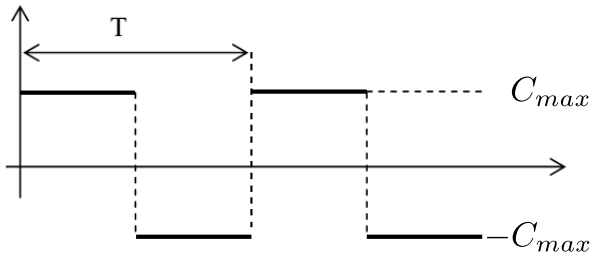


Figure 4: External load.