Advanced Dynamics of Mechanical Systems

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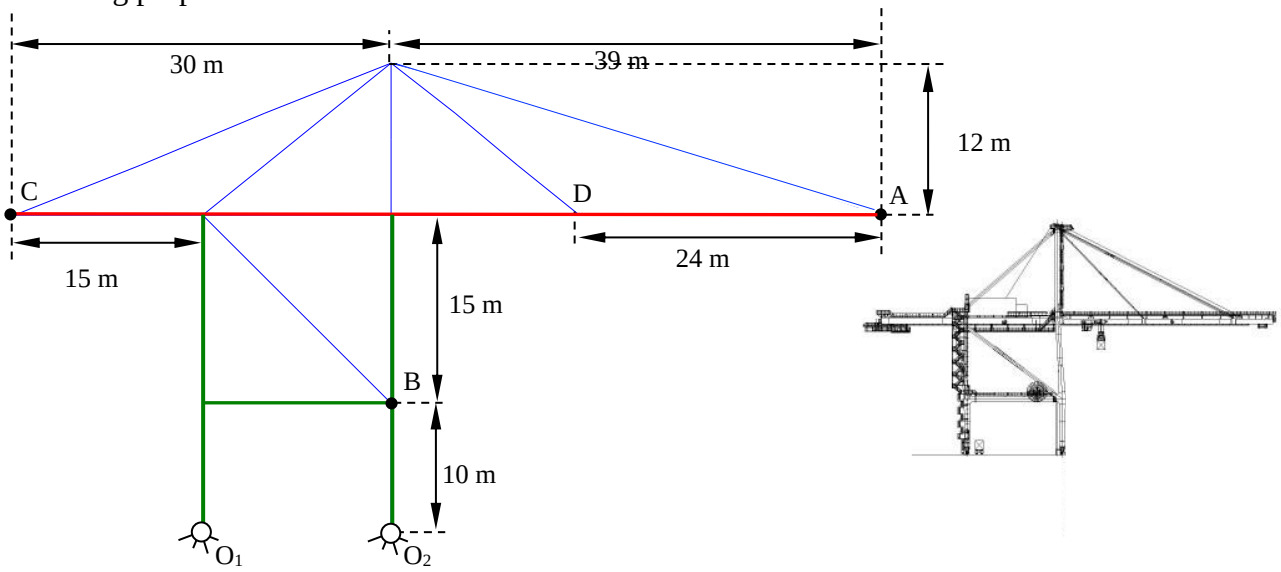
Assignment 2 – AY 23-24

Consider the structure shown below, representing a harbour crane made of steel beams, with the following properties



	m[kg/m]	EA [N]	EJ[Nm2]
Red beams	312	8.2E9	1.4E9
Green beams	200	5.4E9	4.5E8
Blue beams	90	2.4E9	2.0E8

Damping is defined according to the "proportional damping" assumption: $[C]= \alpha[M]+\beta[K]$, with $\alpha=0.1\ s^{-1}$ $\beta=2.0$ E-4 s.

1. Define a FE model of the structure in the 0-8 Hz frequency range considering a safety factor equal to 2.
2. Calculate the structure's natural frequencies and vibration modes up to the 3rd mode. Plot the mode shapes with the indication of the associated natural frequencies.
3. Calculate the structure frequency response functions which relate the input force applied at position A in vertical direction to the outputs vertical displacement at point A and horizontal displacement at point B. Assume the input force to vary in the 0-8 Hz frequency range and set the frequency resolution to 0.01 Hz.
4. Using the modal superposition approach and considering the structure's first two modes, calculate the frequency response functions which relate the same input force of question 3 (vertical force applied in node A) to the horizontal displacement of node B. Plot the corresponding magnitude and phase diagrams superimposed to those obtained in item 3. Point out the differences and comment the results.
5. Calculate the structure frequency response function relating the input force applied at position C in vertical direction to the output axial force in the right column evaluated at point O_2. Assume the input force to vary in the 0-8 Hz frequency range and set the frequency resolution to 0.01 Hz.
6. Compute the static response of the structure due to the weight of the entire structure. Plot the deformed shape of the structure compared to the undeformed configuration and compute the value of the maximum deflection.
7. *Optional* - Calculate the vertical displacement time history of point A, taking into account a moving load traveling between points D and A. The load begins with zero initial velocity, uniformly accelerates over the first 8 meters, keeps a constant velocity over the next 8 meters and then decelerates until reaching point A with null velocity. Total time to travel from D to A is 20s.