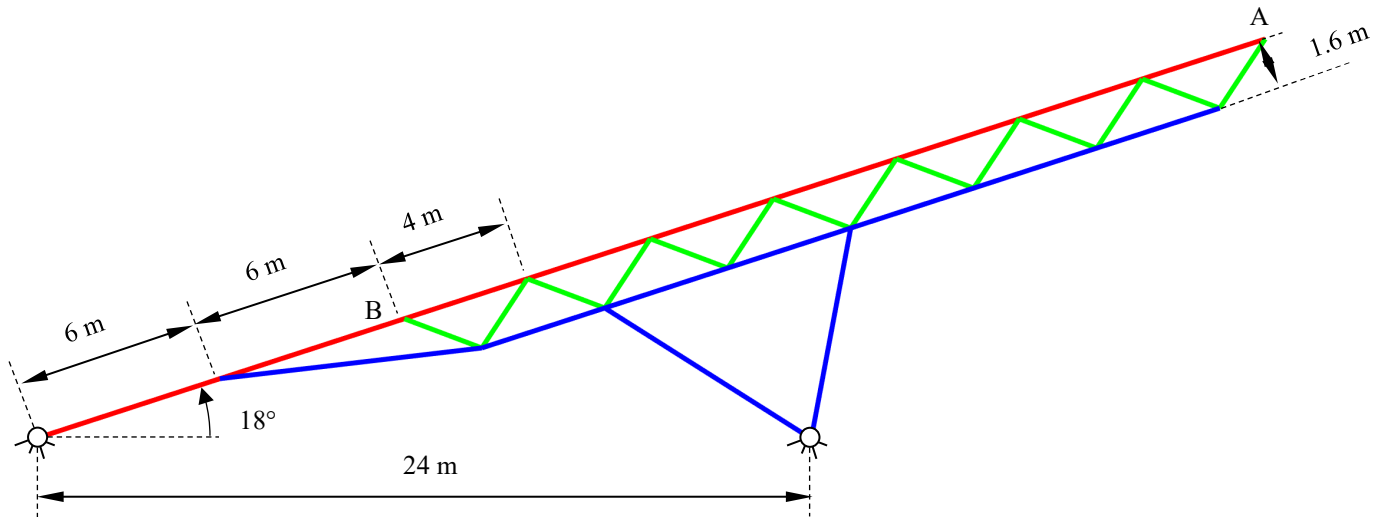


Advanced Dynamics of Mechanical Systems

Prof. Melzi

Assignment 2 – AY 24-25

Consider the structure shown below, representing a coal hauling conveyor belt made of steel beams, with the following properties



	M [kg/m]	EA [N]	EJ [Nm ²]
Red beams (IPE 220)	26.2	6.9076E8	5.7380E6
Green beams (IPE 100)	8.1	2.1362E8	3.5400E5
Blue beams (IPE160)	15.8	4.1586E8	1.7995E6

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

1. Define a FE model of the structure in the 0-20 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 vertical displacement at point B. Assume the input force to vary in the 0-20 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 vertical 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. 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 vertical deflection.
6. *Optional 1* - Calculate the vertical displacement time history of point A, taking into account a moving load traveling between points B and A. The load travels at a constant speed of 2 m/s and then falls from the end of the structure.
7. *Optional 2* – Based on the results of point 5, suggest a possible modification to the structure with the aim to reduce the maximum vertical deflection of the structure free extremity of 50% with a maximum increase in the total mass of the structure of no more than 20%.