Tutorial - Modelling in structural dynamics

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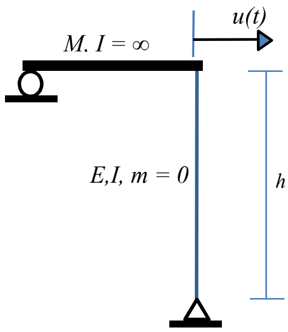
1. By using the equation for the flexural stiffness of a cantilever ($k_{\text{flexural,cantilever}} = 3EI/(L^3)$, demonstrate why the equation for the maximum displacement of a simply-supported beam loaded by a vertical point load P at midspan can be evaluated with the expression:

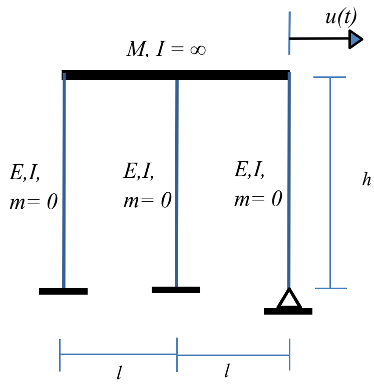
$$u_{\max} = \frac{PL^3}{48EI}$$

2. For the following structures:

   - Determine the minimum number of degrees-of-freedom that you will use to study these systems
   - Formulate their equation of motion assuming an external forcing action of $F(t) = 0$
   - Calculate the natural frequency of each system



(a)



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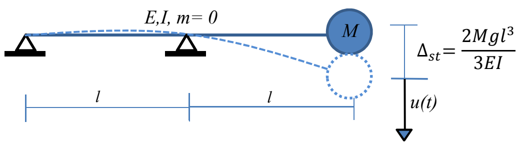

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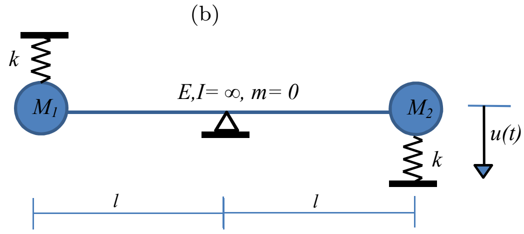


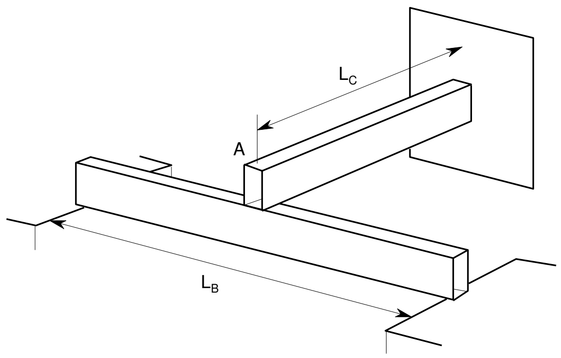
(d)

3. For the frame of Exercise 2b. Determine the second moment of area of the section, I, required to satisfy a maximum admissible stress of σ^* (at all sections of the structure).

4. For the frame of Exercise 2b. Determine the second moment of area of the section, I, required to satisfy a maximum admissible horizontal displacement of u^*.

5. For the frame of Exercise 2b. What would be the limit value of hight over horizontal displacement h/u that will render flexibility requirements (motion) the governing criteria for its design?

6. Consider the propped cantilever shown in the figure below. The beams are made from the same steel section and have lengths as shown on the diagram. Determine the natural period of this system if a large mass, M, is placed at the intersection of the beams at point A. The weight of the beams in comparison with the mass M is very small.



7. Determine an expression for the effective stiffness of the following systems: