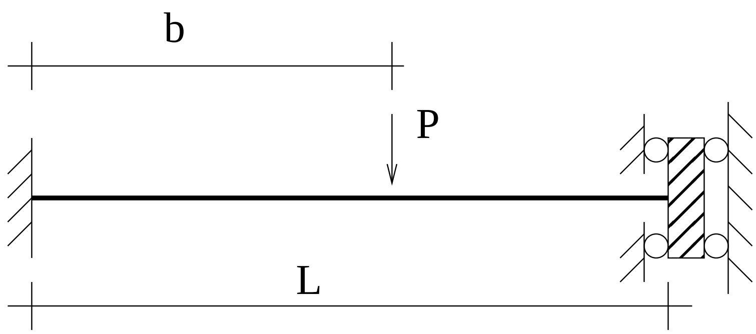
UNIVERSITY OF CALIFORNIA BERKELEY
Department of Civil Engineering
Spring 2010

Structural Engineering,
Mechanics and Materials
Professor: S. Govindjee

HW 3: Due Thursday Feb. 10

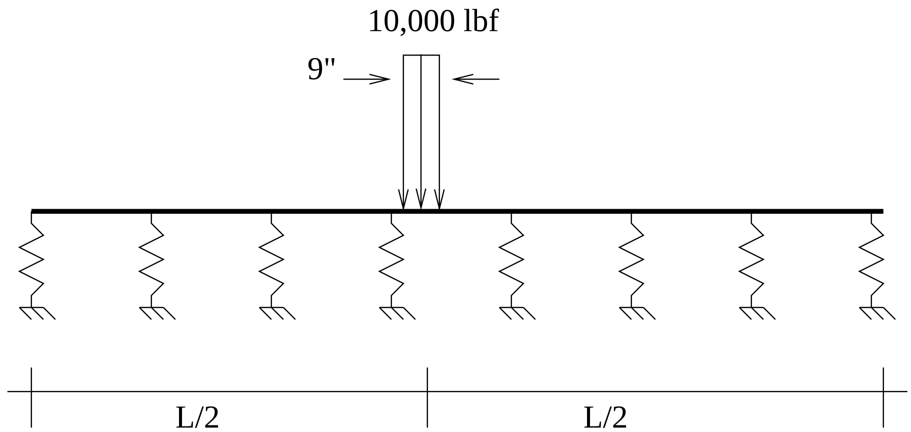
1. Consider an elastic beam of length $L = 10$ ft with constant Young's modulus $E = 30 \times 10^6$ psi, and cross sectional area moment of inertia $I = 256$ in^4. The beam is subject to a a point force P at $x = b = 6$ ft. Determine the transverse stiffness at $x = b$; i.e. determine $k = P/v(b)$. Modify your program from Lab 2 to solve this problem.



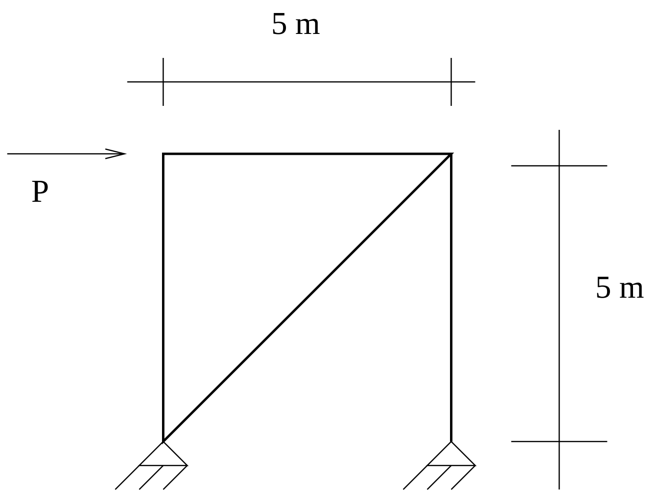
[Remark: P is intentionally unspecified. Why?]

2. Consider a beam supported by a continuously distributed spring foundation (such a railroad raid or grade beam); such supports are know as *Winkler foundations*[1] . Assume the beam is 100 ft long with a Young's modulus of $E = 30 \times 10^6$ psi and a cross sectional area moment of inertia $I = 87.4$ in^4. Assume a foundation stiffness of $k = 100$ lb/in^2 and determine the maximum rotation (in absolute value) in the beam for a 10×10^3 lb load distributed over 9 in at the beam's center. Note that for this problem the governing equation is given by $EIv(x)'''' = q(x)$, where $q(x) = q_{\text{applied}}(x) - kv(x)$. For boundary conditions, assume zero moment and shear. Modify your program from Lab 2 to solve this problem.

[1] If you are interested in historical matters, you can find Emil Winkler's original developments in his 1867 book on Elasticity and Strength on Google Books. Search on "Die Lehre von der Elasticitaet und Festigkeit" pages 182-184.



3. For the truss shown construct the $\boldsymbol{A}^T$ matrix and the system's equilibrium equations.



4. For the truss shown, determine its degree of indeterminacy.