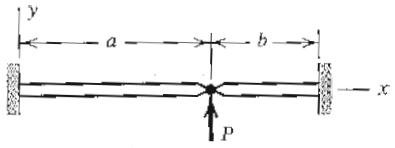
ME 712, Finite Element Method Applications Midterm Exam, Spring 2009

One formula sheet, closed notes, open book. Test books will be provided. 1 hour, 15 min. *Problems must be done in order in the test books.* 10 points each.

1. Two collinear cantilever beams are connected by a frictionless hinge as shown. Flexural stiffness $EI_z$ is the same for both beams. Load $P$ and the deflections are confined to the $xy$ plane. Write the stiffness matrix that operates on the "active" dof. Ignore transverse shear deformation.




2. Determine the 1,3 element of the stiffness matrix for a beam in local coordinates (the beam being between $x = 0$ and $x = l$) presuming $E$ is constant, but $I(x) = I_1 + (I_2 - I_1)\frac{x}{l}$. *Set up all math in matrix form without multiplying out the matrices, but solve only for* $K_{14}$.

$$N = \begin{bmatrix} 1 - 3\frac{x^2}{l^2} + 2\frac{x^3}{l^3} & x - 2\frac{x^2}{l} + \frac{x^3}{l^2} & 3\frac{x^2}{l^2} - 2\frac{x^3}{l^3} & -\frac{x^2}{l} + \frac{x^3}{l^2} \end{bmatrix}$$

3. To elevate the end of a cantilever beam without rotating it, as shown, force and moments as shown are required. From the information in the figure, fill in as much of the stiffness matrix as possible. Explain (briefly) your method/logic.