UNIVERSITY OF CALIFORNIA BERKELEY
Department of Civil Engineering
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Structural Engineering,
Mechanics and Materials
Professor: S. Govindjee

HW 7: Due Thursday March 17

1. **(20pts)** Consider a doublely built-in beam of length L with a transverse load of magnitude P in the positive direction at $x = L/2$.

   (a) By approximately minimizing the potential energy of the system find the displacement field for the beam: use a subspace with one degree of freedom.

   (b) Compare your approximation to the exact answer with an accurate plot (as normalized non-dimensional deflection versus non-dimensional position). Make sure that you clearly label your axes, have a proper aspect ratio, legend, etc.

   (c) Assess the accuracy further by computing the relative displacement error at the middle of the beam (as a percentage).

   [Hint: $\cos^2 \alpha = \frac{1}{2} + \frac{1}{2}\cos(2\alpha)$.]

2. **(10 pts)** Carefully derive the matrix equations that would result from using the method of Ritz on an elastic tension-compression bar problem fixed at its right end and subject to a distributed force $b(x)$.

3. **(30 pts)** Consider a linear elastic bar with cross-sectional properties $AE = 330\times10^6$ lbf and length 4 ft which is built-in at both ends. The bar is loaded with a distributed force $b(x) = 100$ kips/ft. Solve for the displacement and strain fields in the bar using the method of Ritz and the basis functions $f_n(x) = \sin(n\pi x/L)$ for $n = 1, 2, 3, \ldots$. How many terms in the expansion are required to reduce the relative L^2 error in the displacements to 1%? To compute the errors you can use an approximate quadrature, say something simple like Riemann sums. How many terms are needed to achieve the same with respect to the strains?