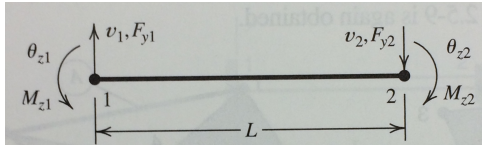


Open notes, open book. Test books will be provided. *Problems must be done in order in the test books.* 10 points each.

1. Derive shape function 4 for the Euler Bernoulli beam below using physical coordinates.



2. Derive shape function 4 for the beam above in natural coordinates. You may either a) rederive, or b) use a Jacobian. Your choice.
3. The shape functions for a bilinear Q4 element are given by, heck, use your book. If nodes 1-4 are at locations (0,0), (1,0), (1,1), (0,1), and a distributed load of  $\Phi(x, y) = y\hat{\mathbf{i}} + 0\hat{\mathbf{j}}$  is applied to the right side of the element. Determine the nodal force on node 3 in the  $x$  direction.
4. Calculate the percent error of

$$\int_0^\pi \sin \theta d\theta$$

performed using 2 point Gauss integration.

Table 1: Approximate Gauss point integration values

# points	$\xi_i$	$w_i$
1	0	2
2	$\pm \frac{1}{\sqrt{3}}$	1
3	$0, \pm \sqrt{0.6}$	$\frac{8}{9}, \frac{5}{9}$
4	-0.86, -0.34, 0.34, 0.86	0.35, 0.65, 0.65, 0.35