ME 712, Finite Element Method Applications Exam 2, Spring 2006

Formula sheet, closed notes. Test books will be provided.

1. Determine the stiffness matrix of a 3-noded rod element with the center node equidistant from the ends using Gauss quadrature. Presume constant area and density.

2. Determine the 1,4 element of the stiffness matrix for a standard Euler Bernoulli 2-noded beam element presuming E is constant, but I at the left end is I_1 and I at the right end is I_2.

3. Determine the centroid $\bar{x}$ of a quadratic (LST) triangular element assuming nodes at (0,0), (1,0), (0,1), (0.5,0), (0.5,0.5), (0,0.75) using Gauss point integration. Note that $\bar{x} = \frac{\int_A y dx dy}{\int_A dx dy}$. Explain any assumptions. Show all work. No credit will be given for integration carried out other than as specified.

	Linear	Quadratic
$N_1 =$	$1-r-s$	$(1-r-s)(1-2r-2s)$
$N_2 =$	r	$r(2r-1)$
$N_3 =$	s	$s(2s-1)$
$N_4 =$		$4r(1-r-s)$
$N_5 =$		$4rs$
$N_6 =$		$4s(1-r-s)$

4. Find the stress at (x, y)=(1,2) of a bilinear quadrilateral (Q4) element with nodes 1-4 at (0,0), (1,0), (1,2), and (0,1) in terms of u_3 and v_3 (presume all other nodal displacements are zero).