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

One formula sheet to be turned in. Open book. **Problems must be done in order in the blue books.**

1. Write the mass matrix for a rod element in 2-D. Presume the element lies parallel to the x axis. Apply constraints to the governing equation such that $d_2 = -d_4 = -\theta\frac{l}{2}$ (vertical displacement of the left node is equal in magnitude and opposite in direction to the motion of the right node) and determine the reduced mass matrix. d_2, and d_4 should not be retained degrees of freedom in the final model, but θ should be.

2. Apply matrix deflation to the following matrix

$$\begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$$

for the eigenvalue $\mu = 3$ with eigenvector $\mathbf{v} = \begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} \end{bmatrix}$

3. Describe the properties common to all stiffness matrices of individual 3-D finite elements.

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

5. For each of the following methods, answer the questions: a) what does this method do? b) when is this method used, plus any other special requests as listed?

   One sentence per issue being answered. That means 4 sentences for item 1, 2 sentences for item 2, etc.

   (a) Guyan reduction (also give 2 examples)

   (b) SEREP

   (c) Newmark β

   (d) Power method (plus, what method must always be used in conjunction with the power method?)

   (e) Subspace iteration (plus, what method must be used before subspace iteration when the system has rigid body modes). Why?