

# Open Book, Open Notes, Open Web, Time Limited Test1 for Mech417

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JEA08417

Available beginning February 28, 2008 and due March 13, 2008 5pm at the ME "In-Box".

## Cover Page

### Instructions

**You must work alone on this test. If you are not familiar with the Rice Honor system then review it before proceeding. Once you go beyond this cover page you have a maximum of two hours to work on this test, excluding an optional 30 minute break that prohibits consulting reference materials.**

Name \_\_\_\_\_ Start time \_\_\_\_\_ Finish time \_\_\_\_\_

- List the main advantages and disadvantages of the finite element method.
- Briefly explain the operations of scatter and gather and the type of data they operate upon.
- A plane frame element in a bridge is connected to nodes 23 and 35 of the structure. What are the system equation numbers for the three degrees of freedom located at node 23?
- Four linear springs with the same stiffness,  $k$ , are joined as listed in the connection table as shown. Assemble their 2 by 2 stiffness matrices into the system stiffness matrix.

e	j	k
1	3	2
2	2	3
3	2	1
4	3	1

- An integral form yields the (singular) matrix system below, before any boundary conditions are applied. Modify the matrices to impose the boundary condition that  $u_3 = 5$ . Let  $R_3$  denote the

corresponding reaction.

$$\begin{bmatrix} 44 & -50 & 0 \\ -50 & 88 & -50 \\ 0 & -50 & 44 \end{bmatrix} \begin{Bmatrix} u_1 \\ u_2 \\ u_3 \end{Bmatrix} = \begin{Bmatrix} 2 \\ 12 \\ 10 \end{Bmatrix} + \begin{Bmatrix} 0 \\ 0 \\ R_3 \end{Bmatrix}$$

- Assume that the solution to the above system is  $u = [18.8 \quad 16.5 \quad 10]$ . What is the value of the reaction  $R_3$ ?
- A plane frame member goes from its first node to its second with a slope of 12 horizontal to -5 vertical. What are the two direction cosines for that member? What is the coordinate transformation matrix for that member?
- A transient conduction problem in 1-D has an element square specific heat matrix of the form  $\mathbf{k}_\rho^e = \int_A \rho(x, y) \mathbf{N}^e \mathbf{T}^T [\mathbf{N}^e] dL$ , where  $\rho(x, y)$  are given data. Outline the formation of this matrix by numerical integration.
- An axial bar has a constant distributed axial load from its mid-point to its free end. Create a mesh of three bar elements, form the three element load vectors. **Do not form** the stiffness matrices.
- What should be the sum of all the terms in the above system load vector, and why?
- A linear parametric mapping is used from a local space to the physical length  $L^e$  of the element. What is the geometric Jacobian of that transformation when the local space is a)  $0 \leq r \leq 1$ , and b)  $-1 \leq a \leq 1$ ?

### Mech 517 only

- The geometric mapping to physical  $x(r)$  positions is carried out using a quadratic mapping through the element's three node points  $x_1^e, x_2^e, x_3^e$ . If that quadratic interpolation is done in the parent local space of  $0 \leq r \leq 1$  what is the Jacobian of the transformation,  $J(r)^e$ ?
- Given the global axis reactions of a plane frame member as  $\{R\}_G$  discuss how you would obtain the corresponding reaction values,  $\{R\}_L$ , in the local axis system. That is, how do you find the joint force components parallel and perpendicular to the member