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

JEA11417

Available beginning Feb. 17, 2011 with hardcopy solution due 5pm Feb 24
at the ME "In-Box" wall slot between rooms ME 109 and 108.

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.

This is an open book, open notes and open course web page test.

Mech 417/517, Finite Element Analysis, Prof. Akin, Spring 2011

Name _____ **Begin Time** _____ **End Time** _____

1. Briefly explain the operations of scatter and gather and the type of data upon which they operate.

2. What are the essential and non-essential boundary conditions for an ordinary differential equation that is: a) second order, b) fourth order?

3. What are the major advantages and disadvantages of a finite element analysis?

4. An axial bar has a distributed axial load per unit length, *w*, from its fixed left support to half way to its free right end. Create and show a mesh of three two noded bar elements, form the three element load vectors. Do not form the stiffness matrices.

5. Four line elements, with two nodes each, are joined as listed in the connection table and sketch shown below.

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     e  j  k       1            2              3  nodes
     1  2  1     *------(1)-------*-------(2)-------*                    typical element
     2  2  3     |            |          | (element)      *----(e)----*
     3  1  2     *------(3)-------*          |                1        2
     4  3  1     *--------------------(4)------------*
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Let the source vector for a typical element be written as $C^e = \left\{\begin{matrix} C_1 \\ C_2 \end{matrix}\right\}^e$, write out the four resultant source terms that result from scattering (assembling) all elements to the system level. (That is, write each entry as the sum of scalar contributions C_k^e for e = 1, 2, 3, 4 and k = 1, 2.)

6. What are the primary uses of the geometric Jacobian in a typical element?

7. List the major phases involved in the numerical solution of a finite element problem.

8. We have presented two ways for modifying a singular matrix system to include an essential boundary condition, necessary to render it non-singular. Briefly describe one of the methods. What is a disadvantage of that method?

9. A three node unit triangle has nodal property values of $P^{e^T} = [p_1 \quad p_2 \quad p_3]$. What is the corresponding property value at the interior point (0.3, 0.2), in unit coordinates?

10. The above triangle has corner x-coordinates of $x^{e^T} = [x_1 \quad x_2 \quad x_3]$. Evaluate $\partial x/\partial r$, $\partial x/\partial s$ for the triangle.

MECH 517 (or 417 Bonus)

11. Explain why the sum of the Gaussian quadrature weights tabulated over 0 <= r <= 1, must equal unity, while those tabulated over -1<= a <= 1 must sum to 2.

12. The concentration C(x) of a species in 1D mass transport is:

$$-\frac{d}{dx}\left(D(x)\frac{dC(x)}{dx}\right) + u(x)\frac{dC(x)}{dx} + K(x)C(x) = m$$

where D, u, K and m are supplied data. Write the integrated by parts Galerkin equivalent integral form for this system over $0 \le x \le L$.

13. The consistent mass matrix for any element is $\mathbf{m}^e = \int_L \mathbf{N}^{e^T}\rho\mathbf{N}^e dx$. For a four-node line element (L4) in the unit space 0 <= r <= 1 explain how many quadrature points would be required to integrate this matrix exactly if the density ρ is: a) constant, b) $\rho = \rho_0 x^2$.