Open Notes, Open Book,
Time Limited Final Test for Mech417/517

JEA19417

Available beginning April 24, 2019 with hardcopy solution due 5pm April 30 at the ME "Dropbox" wall slot near room ME 109. Students that are out of town may submit their test by email.

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 15-minute break that prohibits consulting reference materials.

The test is open books, open notes, and open web (if you like to waste time).

Mech 417/517, Finite Element Analysis, Prof. Akin, Test 2 Spring 2019

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

Begin Day _____

1. What are the main differences between 2D and axisymmetric Poisson formulations by finite element analysis?

2. A radial model of a gas centrifuge involves a sixth order elliptical PDE. After integration by parts what degree of spatial derivative appears in the integral form? What is defined by the essential boundary conditions? What is defined by the non-essential boundary conditions?

3. A surface region for a second order elliptical PDE, for u, has a mixed boundary condition of the form: $\mathrm{k_n}\frac{\partial \mathrm{u}}{\partial \mathrm{n}} = \mathrm{mu} + \mathrm{s}$. What are the integral forms of the matrices defined by this boundary condition?

4. If you are calculating a plane-stress analysis with an eight node quadrilateral element;
   a) How many unknowns are at each node?
   b) How many stresses are there in any element?
   c) What is the size of the element strain-displacement matrix, $\mathbf{B^e}$?

5. If you are calculating a plane-strain analysis with an eight node quadrilateral element;
   a) How many unknowns are at each node?
   b) How many stresses are there in any element?
   c) What is the size of the element strain-displacement matrix, $\mathbf{B^e}$?

7. If you are calculating a axisymmetric stress analysis with an eight node quadrilateral element;
   a) How many unknowns are at each node?
   b) How many stresses are there in any element?
   c) What is the size of the element strain-displacement matrix, $\mathbf{B^e}$?

8. If you are calculating a Poisson analysis with a eight node quadrilateral element how many quadrature points do you need in each parametric direction?

9. In a FEA 2D torsional stress analysis of a straight shaft the primary unknown is: _____
   a) torque b) twist angle c) stress function
   d) shear stress e) shear modulus f) none of the above

10. In a FEA torsional stress analysis of a straight shaft the required post-processing results are: _____
    a) torque b) twist angle c) stress function
    d) shear stress e) shear modulus e) none of the above

11. In a FEA torsional stress analysis of a straight shaft what is the shear stress at a sharp re-entrant corner?

a) zero b) value of the stress function c) integral of the stress function
d) infinite e) none of the above

12. In a FEA torsional stress analysis of a straight shaft what is the shear stress at a sharp exterior corner?

a) zero b) value of the stress function c) integral of the stress function
d) infinite e) none of the above

13. A material that is the same at all points is ___

a) homogeneous b) non-homogeneous c) isotropic
d) anisotropic e) orthotropic

14. How are the physical derivatives of the interpolation functions, $\mathbf{N^e}$, evaluated at a point within an element?

15. In a FEA torsional stress analysis of a straight shaft what is the applied torque proportional to? _____

a) the length b) value of the stress function c) integral of the stress function
d) stress function gradient e) none of the above

16. The magnitude of a heat flux vector always depends on the _____

a) temperature b) temperature gradient c) thermal conductivity
d) specific heat e) convection coefficient

17. In a continuum solid structural analysis what is the sum of the terms in the element stiffness matrix? ___

18. In a continuum solid structural analysis what is the sum of the terms in the element mass matrix?___

19. In a continuum solid structural analysis what is the sum of the terms in the resultant element force vector due the body weight? ___

20. In a transient heat conduction problem what is the sum of the terms in the element heat capacity matrix? ___

21. What is the sum of the terms in the element Lagrangian interpolation matrix?___

22. What is the sum of the terms in the element parametric derivative matrix for a Lagrangian interpolation? ___

23. In a continuum plane thermal analysis what is the sum of the terms in the element conduction matrix? ___

24. The physical partial derivative of a quantity is obtained from the parametric partial derivative of a quantity (when one-to-one) by : _____

a) adding the determinant of the Jacobian b) pre-multiplied by the inverse of the Jacobian matrix
c) pre-multiplied by the Jacobian matrix d) adding the interpolation functions
e) post-multiplied by the Jacobian matrix f) post multiplied by the inverse of the Jacobian matrix

25. How is the initial condition utilized in the matrix equations of a transient heat transfer formulation?

Additional MECH 517 (or 417 Bonus) questions

1. State the matrix expressions for the system scalar strain-energy, external mechanical work, and kinetic energy of a system in terms of the assembled system stiffness matrix, **[K]**, mass matrix **[M]**, resultant force **{C}**, system displacements **{U}**, and velocities **{**d**U**/dt**}.**

The general form for the resultant nodal forces on a solid element due to an initial strain, $\boldsymbol{\varepsilon_0}$, is

$$\boldsymbol{C_0^e} = \int_\Omega \boldsymbol{B^{eT}}\, \boldsymbol{E^e}\boldsymbol{\varepsilon_0}\, d\Omega.$$

2. What is the source of the values stored in the $\boldsymbol{E^e}$ matrix?

3. How many columns does $\boldsymbol{E^e}$ it have?

4. What is the source of the non-zero values stored in the $\boldsymbol{B^e}$ matrix?

5. What was the most interesting thing that you learned about finite element analysis, and why?