Register Number.....

M.E. DEGREE EXAMINATIONS: DECEMBER 2008

First Semester

CAD / CAM

P07CC102 Finite Element Analysis

Time: Three hours **Maximum Marks: 100**

PART A (20 x 1 = 20 Marks)

1. A one dimensional cubic element comprises of _____ nodes.

   A. 3 B. 4 C. 5 D. 6

2. One important property of stiffness matrix is that

   A. The main diagonal has only negative values.

   B. The matrix is symmetrical.

   C. The sum of all the coefficients in any column must be positive.

   D. The sum of all the coefficients in any row must be negative.

3. The maximum largest difference in the node numbers occurring for all elements of an assemblage is 4 and the number of degrees of freedom at each node is 3. The bandwidth of global characteristic matrix is

   A. 12 B. 15 C. 16 D. 20

4. The boundary conditions specified for a one-dimensional steady-state heat conduction problem are given below:

   $K_0 [dT(0)/dx] = q_0$ and $k_L [dT(L)/dx] = q_L$. This type of boundary condition is called_____.

   A. Essential B. Dirichlet C. Nuemann D. Mixed

5. A triangular element has nodal coordinates A(1,2), B(5,3) and C(4,6). At an interior point P, the x coordinate is 3.3 and $N_i = 0.3$. N_2 is

   A. 0.9 B. 0.7 C. 0.3 D. 0.2

6. Total potential energy of an elastic body is

   A. Body force + surface force + strain energy + work potential

   B. Body force + strain energy + work potential

   C. Surface force + strain energy + work potential

   D. Strain energy + work potential

7. _____ elements are used to idealize the axisymmetric problems.

   A. Linear tetrahedron B. Hexahedron C. Torus triangular D. Brick

8. Plane stress analysis is carried out for

A. A ring press fitted on a shaft

B. Splined shaft

C. Dam subjected to horizontal load

D. Long cylindrical member

9. The type of interpolation function used to define field variable when isoparametric elements are used is _____

A. Different from the one used to define problem geometry

B. Same as used to define problem geometry

C. Different from the one used to define complex elements

D. Same as used to define complex elements

10. The value of the $\iint L_1^p L_2^q L_3^r \, dA$ is

A. [p!q!r! /(p+q+r+1)!] A

B. [p!q!r! /(p+q+r+2)!]2A

C. [p!q!r! /(p+q+r+3)!]3A

D. [p!q!r! /(p+q+r+4)!]4A

11. The method applied to remove the degrees of freedom of internal nodes is called

A. Point Collocation B. Rayleigh Ritz C. Collocation D. Condensation

12. Identify the wrong statement

A. Isoparametric is a name that implies certain properties for an element that is integral i a normalized space.
B. An interpolation function is not used to approximate the physical parameter along the boundaries and interior of the element.
C. When the same node locations are used for both approximations, the element is said t be isoparametric.
D. When fewer nodes are used to define the geometry than are used to define the shape function, the element is termed subparametric.

13. The chassis frame of a vehicle when it encounters a pot hole needs to be analyzed using the following analysis type:

A. Static B. Transient dynamic C. Modal D. Hormonic

14. The coefficient "m_{12}" of consistent mass matrix of beam element is

A. 0.03 ρAl^2 B. 0.05 ρAl^2 C. 0.1 ρAl^2 D. 0.2 ρAl^2

15. The lumped mass matrix obtained after assembling 1D spar element mass matrices is

(a) singular, (b) non-singular, (c) symmetric and (d) unsymmetric.

In the above four conditions, following is TRUE

A. a and c B. a and d C. b and c D. b and d

16. The number of modes of vibration for a cantilever beam modeled with four 2D beam (3 DOF per node) elements is

A. 6 B. 8 C. 12 D. 24

17. The temperature gradient matrix is analogous to the following matrix

A. Material B. Displacement C. Stress D. Strain

18. The steady-state one-dimensional heat conduction equation in cylindrical coordinate is given by

A. $(d/dr)\,[k\,(dT/dr)] = 0$ B. $(d/dr)[rk\,(dT/dr)] = 0$

C. $(d/dr)[r^2\,k\,(dT/dr)] = 0$ D. $(d/dr)[r^3k\,(dT/dr)] = 0$

19. For a time-dependent problem symbolized as [K] {D} = {R}, in nonlinear analysis [K] and/or {R} are regarded as _____.

A. Constants B. Step Funtions C. Independent of {D} D. Functions of {D}

20. A material is called nonlinear if stresses $\{\sigma\}$ and strains $\{\varepsilon\}$ are related by a _____.

A. Matrix of constants

B. Strain-dependent matrix

C. Stress-dependent matrix

D. force-dependent matrix

PART B (5 X 16 = 80 Marks)

21. (a) (i) Explain in detail the various considerations to be taken in the discretization process of domain. (10)

(ii) Describe the areas in which finite element analysis could be used as a tool of engineering analysis. (6)

(OR)

(b) For the plane truss supported by the spring at node 1 in Fig.1, determine the nodal displacements and stresses in each element. Let E = 210 GPa and Cross sectional area, $A = 5.0 \times 10^{-4}\ m^2$ for both truss elements.

22. (a) Derive stiffness matrix, load matrix of a constant strain triangular element when subjected to uniformly distributed load on any one of its side and body force due to self weight.

(OR)

(b) For the linearly varying distributed load on the axisymmetric conical surface shown in Fig.2, determine the equivalent point load vector T.

23. (a) The Cartesian coordinates of the corner nodes of an isoparametric quadrilateral element are given by (4, 4), (10, 2), (8, 12) and (6, 8). The components of displacement parallel to (x, y) axes at four nodes of the element are found to be (0, 0), (5.08×10^{-5}, 7.62×10^{-5}), (1.524×10^{-5}, 8.128×10^{-5}) and (0, 0) m respectively. Find the stress at the point r = 0 and s = 0 in the master element. To which point does it represent in the original element? Assume plane stress condition. Take E = 200 GPa and Poisson's ratio = 0.3.

(OR)

(b)(i)Explain how the stiffness matrix can be obtained for an isoparametric hexahedral element. (10)

(ii) Evaluate the integral

$$I = \int_{-1}^{1} (5x^5 + 3x^2 - 2)\, dx$$

using the Gauss integration. (6)

24. (a) Formulate the consistent mass matrix for the two dimensional rectangular element ABCD having nodal coordinates A (10,10), B(40,10), C(40,30) and D(10,30). The element has uniform thickness of 3 mm and density $\rho = 7.8 \times 10^{-3}$ kg/mm^3.

(OR)

(b) Find the natural frequencies and modes of vibration of two element simply supported beam by taking advantage of the symmetry about the midpoint.

25. (a) Consider steady-state heat conduction in an isotropic rectangular region of dimension 3a x 2a. The origin of the x and y coordinates is taken at the lower left corner of the region such that x is parallel to the side 3a and y is parallel to side 2a. The boundaries x = 0 and y = 0 are insulated, the boundary x = 3a is maintained at zero temperature, and the boundary y = 2a is maintained at a temperature $T = T_0 \cos(\pi x/6a)$. Determine the temperature distribution using finite element method in the region and the heat required at boundary x = 3a to maintain it at zero temperature.

(OR)

(b) (i) With the help of suitable examples explain the following:

1. Material nonlinearity and 2. Geometric nonlinearity (6)

(ii) Explain any one method of formulating finite element equations to solve material nonlinearity problems. (10)

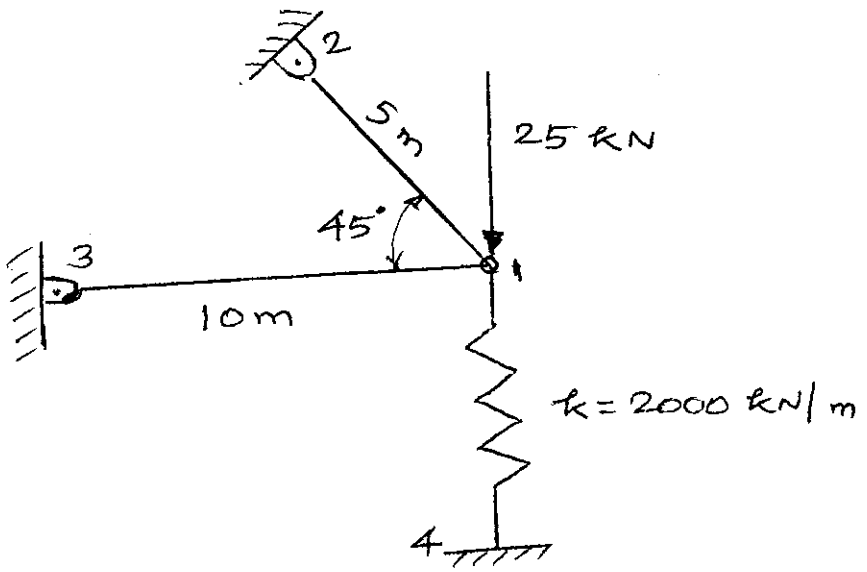

FIG. 1

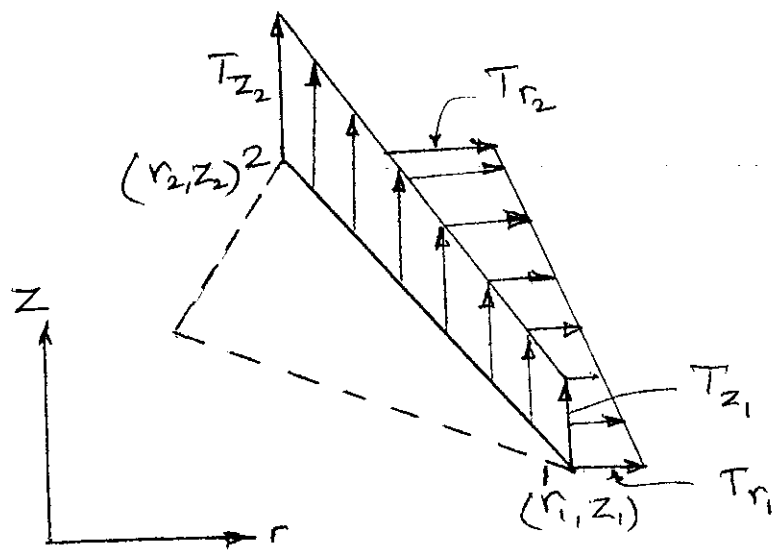

FIG. 2.

****