Register Number: ………………..

B.E DEGREE EXAMINATIONS: MAY 2015

(Regulation 2009)

Sixth Semester

MECHANICAL ENGINEERING

MEC119: Finite Element Analysis

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The interpolation function used in beam element is the order of -----
   a) 1 b) 3
   c) 2 d) 4
2. Assembled stiffness matrix after applying boundary conditions is NOT a -------- matrix.
   a) Singular b) Banded
   c) Symmetric d) square
3. Accuracy of solution -------- with increase of number of elements
   a) Improves b) No change
   c) Reduces d) Depends on other data
4. Conductance matrix is the equivalent of stiffness matrix in
   a) Static structural analysis b) Dynamic analysis
   c) Thermal analysis d) Fluid flow analysis
5. A spur gear of relatively larger face width is usually modeled by
   a) 2D plane stress elements b) 2D plane strain elements
   c) 3D solid elements d) 3D shell elements
6. Strain - displacement matrix[B] for a rectangular element is in the order of
   a) (3 x 6) b) (3 x 8)
   c) (4 x 8) d) (4 x 6)
7. A linear triangular element is also called as --------- element.
   a) CST b) Sub parametric
   c) LST d) Super parametric
8. Thermal load vector for an axisymmetric element is --------.
   a) $[B]^T[D]\{e_0\}2\pi r.\ A$ b) $[B]^T[D][B]\{e_0\}2\pi r.\ A$
   c) $[B][D]\{e\}2\pi r.\ A$ d) $[B]^T[D]\{e_0\}2\pi r.\ t$

9. Gaussian points are used in

a) Stress calculation
b) Numerical integration
c) Displacement calculation
d) Strain calculation

10. The shape functions along an edge of a four node quadrilateral element are

a) Linear
b) Cubic
c) Quadratic
d) Quartic

PART B (10 x 2 = 20 Marks)

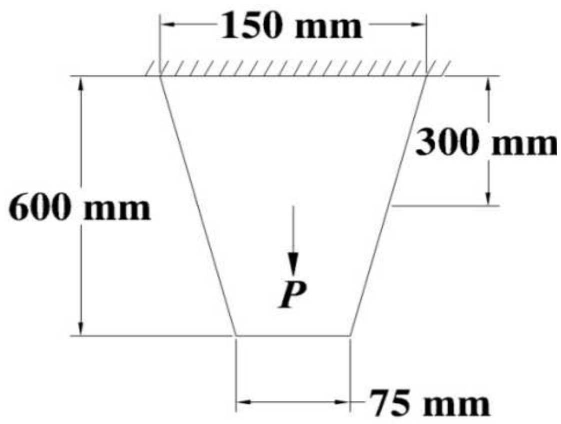
11. Why polynomial type of interpolation functions is mostly used in FEM?
12. What are factors which govern the selection of nodes and elements?
13. List out the properties of stiffness matrix.
14. What is the need for coordinate transformation in solving truss problems?
15. Write down the strain displacement matrix for two dimensional CST elements?
16. Differentiate plane stress and plane strain conditions.
17. What are the ways by which the 3D problem can be reduced to 2D problem?
18. Sketch a finite element model for a long cylinder subjected to an internal pressure using axisymmetric element.
19. Differentiate between Iso parametric, super parametric and sub parametric elements.
20. Write down the shape functions for 4-noded linear quadrilateral element using natural coordinate system

PART C (5 x 14 = 70 Marks)

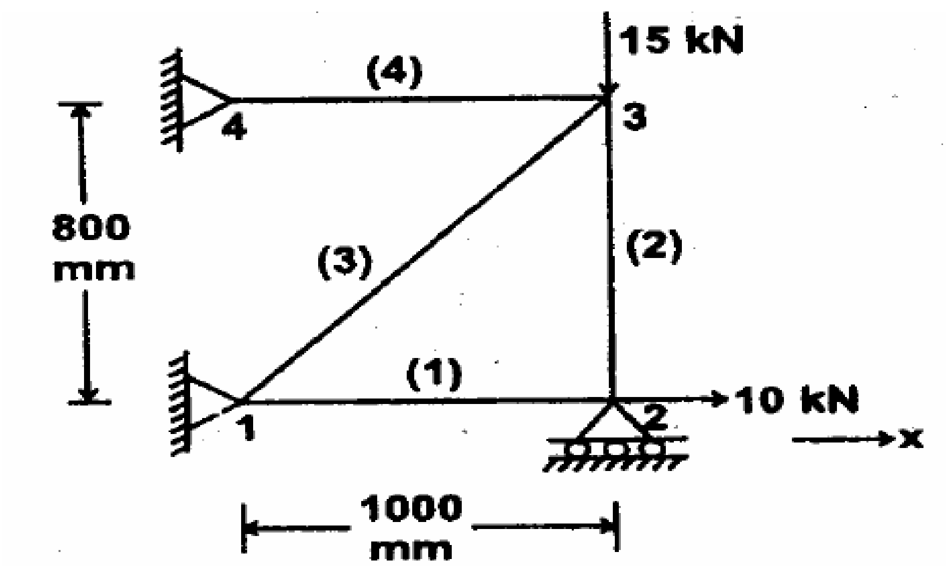
21. a) A simply supported beam subjected to uniformly distributed load 'w' over entire span and also point load of magnitude 'P' at the centre of the span. Evaluate the bending moment and deflection at mid span by using Rayleigh-Ritz method and compare with the exact solution

(OR)

b) Consider a taper steel plate of uniform thickness, t = 20 mm as shown in Fig. The Young's modulus of the plate, material is E = 200 GPa and weight density ρ = 0.78 x 10^{-4} N/mm^3. In addition to its self weight, the plate is subjected to a point load P = 250 N at its mid point. Evaluate the following by modeling the plate with two finite elements: (i) Global force vector {F}. (ii) Global stiffness matrix [K]. (iii) Displacements in each element. (iv) Stresses in each element.



22. a) Consider a four bar truss shown in fig. Evaluate the nodal displacements and element stresses. Take $E = 2.1 \times 10^5$ N/mm^2 and $A = 250$ mm^2 for all elements.



(OR)

b) Derive the FEA Equation for one dimensional heat conduction and convection with heat generation problem using Galerkin's approach.

23. a) The co - ordinates of the CST element are A(10,20),B(5,10) and C(20,10) respectively and the nodal displacements are $u_1 = 0.025$ mm, $u_2 = 0.05$ mm, $u_3 = 0.05$ mm and $v_1 = 0.025$mm, $v_2 = 0.025$mm, $v_3 = 0.020$ mm. Calculate the element strain, element stress, principal stress and principal angle.Assume plane strain condition.Take $\mu = 0.30$ and $E = 2.1 \times 10^5$ N/sq.mm.

(OR)

b) The (x,y) co-ordinates of nodes A,B and C of a triangular element are given by (0,0),(3,0) and (2,4) mm respectively.Evaluate the shape functions N_1 , N_2 and N_3 at an interior point P(2, 2.5) mm for the element. Also evaluate the strain – displacement matrix [B].

24. a) Derive the shape functions and Strain – Displacement Matrix [B] for a axisymmetric triangular element.

(OR)

b) The nodal coordinates of an axisymmetric element are A (6, 7), B (8, 7) and C(5,10). Evaluate the thermal force vector $[F_t]$.The element experiences 25°C increase in temperature. The co-ordinates are in mm. Take $\alpha = 6 \times 10^{-6}$ /°C;
$E = 2 \times 10^5$ N/mm^2 ; $\mu = 0.25$.

25. a) The cartesian coordinates of the corner nodes of an isoparametric quadrilateral element are given by (1,0), (2,0),(2.5,1.5) and (1.5,1). Evaluate the Jacobian marix [J], strain displacement matrix[B] and element stresses at $\varepsilon = 0.75$ and $\eta = 0.75$. The nodal displacement are (0.025, 0.0), (0.005,0.003), (0.0, 0.025) and (0.035, 0.025) mm,

(OR)

b) (i) Evaluate (i) $\int(x^4 + x^2)\,dx$ (ii) $\int(2 + \log(x) + x^2)\,dx$ by applying three point gaussian quadrature between the limits –1 to +1. (6)

(ii) Derive the shape functions and Jacobian matrix [J] for the four node isoparametric quadrilateral element. (8)

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