Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –II Examination Dec. - 2011

Subject code: 1721501 **Date: 09/12/2011**
Subject Name: Finite Element Method
Time: 02.30 pm – 05.00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the meaning of convergence and discuss various criteria to satisfy the convergence of problem **04**

(b) Compute axial displacement of a steel tapered rod of 2 m length, 25 mm diameter at free end and 50 mm diameter at fixed end. The rod is subjected to axial tensile force of 200 kN. Take E=200 GPa. Discretize the rod in to three parts of two noded element. **10**

Q.2 **(a)** Explain strain-displacement matrix [B] and derive strain-displacement matrix for three noded bar element. **07**

(b) For a spring assemblage shown in ***fig. 1***, calculate (i) displacement at node 2 & 3 (ii) reaction at node 1 & 4 (iii) forces in each spring. **07**

OR

(b) Derive the shape function for a 3 noded bar element having node at 0, 0.3L & L. Also find out load vector, if it is subjected to surface traction of 100 kN/m on its full length. **07**

Q.3 **(a)** Explain with illustration, the labeling of nodes in the problem of finite element method. **04**

(b) Analyze the beam as shown in ***fig.2*** using finite element method and draw shear force & bending moment diagram. Consider 2 noded beam element whose shape function is $\{ 1-3S^2+2S^3, L(S-2S^2+S^3), 3S^2-2S^3, L(S^3-S^2)\}$, where S=X/L. **10**

OR

Q.3 **(a)** Derive element stiffness matrix of plane truss element. **04**

(b) For a plane truss shown in ***fig. 3***, determine displacements at each node and the stresses in each element.
Take A=4 cm2. **10**

Q.4 **(a)** Derive the strain displacement matrix for 3 noded CST element. **04**

(b) A plain strain CST element having coordinates of node 1,2 & 3 in cm are (0,0), (10,0) and (5,10) respectively. The displacement vector $[u]^T = [2.0, 1.0, 0.5, 0.0, 3.0, 1.0]^T$ in mm. Evaluate the element stresses σ_x, σ_y, τ_{xy}, principal stresses σ_1, σ_2 and angle of principal plane θ. Take E=200 GPa & poison's ratio $\nu = 0.25$ and thickness of element is 6 mm. **10**

OR

Q.4 **(a)** Explain the concept of isoparametric element in Finite Element Analysis. Also explain the term superparametric and subparametric element. **04**

(b) The nodal coordinates of triangular element are (1,2), (5,3) and (4,6). Find the equivalent nodal loads due to concentrated load of 100 kN applied at the interior point (3,4) in the direction towards (5,3). **10**

Q.5 **(a)** What is Jacobian matrix? Give a procedure to find out Jacobian matrix. **04**

(b) Derive the coefficient K_{22} of the stiffness matrix of a 4 noded isoparametric quadrilateral element whose nodal coordinates are (0,0), (120,50), (90,90) & (0,90) in mm. Take thickness of element is 10 mm. Take 2x2 point Gauss quadrature. **10**

OR

Q.5 **(a)** Explain axisymmetric problems and derive stress-strain relationship matrix for axisymmetric element. **04**

(b) A furnace wall is made up of 228.6 mm thick fire bricks (K=1.25 W/m°C), 127 mm thick insulated bricks (K=0.1389 W/m°C) and 190.5 mm thick red bricks (K=0.868 W/m°C). If the specified temperatures at inner side near fire bricks and outer side near red bricks are 900 °C and 90 °C respectively. Determine the internal temperarure distribution. Consider steady state heat conduction in one dimension only. **10**

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Figures

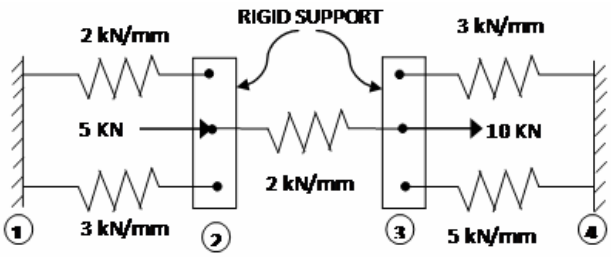

FIG. 1

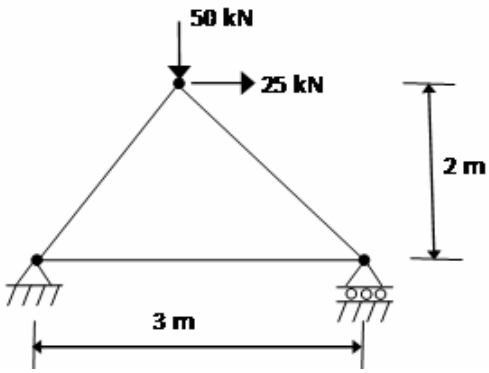

Fig.-3

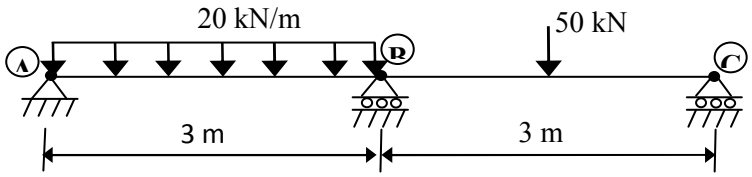

FIG. 2