Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – WINTER 2012

Subject code: 1721501 **Date: 29-12-2012**

Subject Name: Finite Element Method

Time: 10.30 am – 01.00 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)**	Discuss the use of Pascal triangle in selection of displacement function and write displacement function for six noded triangular plane stress element.	**04**
	(b)	Compute axial displacement of a steel tapered rod of 2 m length, 20 mm diameter at free end and 40 mm diameter at fixed end. The rod is subjected to axial tensile force of 100 kN. Take E=200 GPa. Discretize the rod in to three parts of two noded element.	**10**
Q.2	**(a)**	Derive and draw shape function and it's variation for 2 noded beam element using natural coordinates.	**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, 0.4L & L. Find out load vector also, if it is subjected to surface traction of 50 kN/m on its full length.	**07**
Q.3	**(a)**	Explain C^0 and C^1 continuity with illustrations.	**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 horizontal and vertical displacements at node 1 and the stresses in each element. Take A=4 cm^2.	**10**
Q.4	**(a)**	Derive the strain displacement matrix for 3 noded CST element.	**04**
	(b)	A plain strain CST element having coordinates (10,10), (20,10) and (10,25) is having nodal displacements vector $[u]^T = [0.005, 0.002, 0.0, 0.0, 0.005, 0.0]^T$. Evaluate the element stresses σ_x, σ_y, τ_{xy}, principal stresses σ_1, σ_2 and angle of principal plane θ. All dimensions are in mm. Take E=70 GPa & poison's ratio $\nu = 0.3$ and thickness of element is 6 mm.	**10**
		OR	
Q.4	**(a)**	Explain with illustrations plane stress and plane strain problems. Show differences in both types of problems.	**04**
Q.4	**(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 50 kN	**10**

applied at the interior point (3,4) in the direction towards (5,3).

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. **07**

(b) Using natural coordinate system & Lagrange's function, obtain shape function for eight noded rectangular element having four corner nodes and four nodes at the centre of the edges. **07**

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Figures

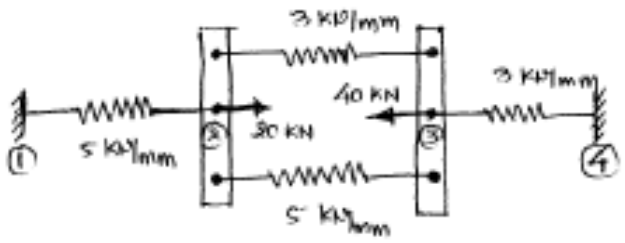

Fig. 4

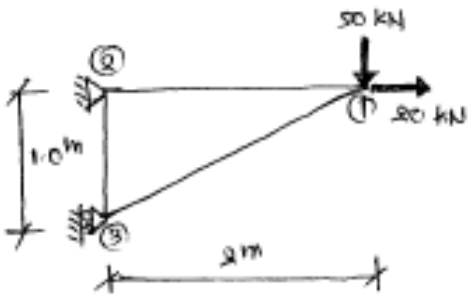

Fig. 3

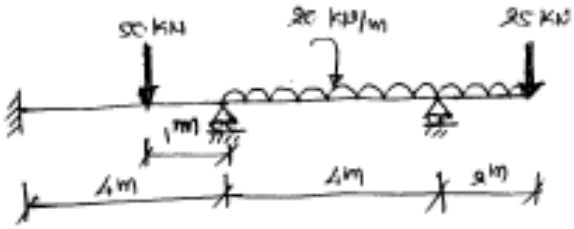

Fig. 2