Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – WINTER • 2014

Subject code: 1722001 Date: 02-12-2014

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)**	Obtain stiffness matrix for the CST element whose nodal co-ordinates are as under: Node-1 (3, -2), Node-2 (1, 5) and Node-3 (7,-9). The value of modulus of elasticity = 2 x 10^{11} N/m2, Poisson's ratio = 0.3 and thickness of element = 8mm.	**07**
	(b)	Explain the terms: Constant strain triangle, Linear strain triangle and Quadratic strain triangle.	**07**
Q.2	**(a)**	Explain the term 'shape functions'. Why polynomial terms are preferred for shape functions in finite element method?	**07**
	(b)	Derive the load vector for two-noded bar element if it is loaded with uniformly distributed load and uniformly varying load along its length.	**07**
		OR	
	(b)	Write short note on pre and post processors.	**07**
Q.3		Using FEM, determine nodal displacements, elemental stresses and reaction forces for a bar subjected to axial force shown in Fig.1. The cross sectional area of AB and BC part is 900 mm^2 and 2500 mm^2, respectively. Modulus of elasticity of of AB and BC part is 0.8 x 10^5 MPa and 2.1 x 10^5 MPa, respectively.	**14**
		OR	
Q.3	**(a)**	Using FEM, determine nodal displacements and reaction forces for a bar subjected to torque shown in Fig.2. The polar moment of inertia of AB, BC and CD part is 1 x 10^7 mm^4, 2 x 10^7 mm^4 and 3 x 10^7 mm^4, respectively. The shear modulus of both parts is 8.0 x 10^7 kN/m^2.	**07**
	(b)	(i) Computers are mandatory for FEM implementation-Justify. (ii) Describe the analytical capabilities and range of application of ANSYS.	**07**
Q.4	**(a)**	Discuss the use of axi-symmetric element in finite element method. Give various strains to be considered for the same. Also give some real life structures which can be solved by axi-symmetric element.	**07**
	(b)	Derive strain displacement matrix for an axisymmetric element. The *r*- and *z*-coordinates of the nodes of triangular element are (0, 1), (4, 0) and (2, 2). Take modulus of elasticity =210GPa, Poisson's ratio = 0.22.	**07**
		OR	
Q.4	**(a)**	For the beam and loading as shown in Fig.3 determine slope at B and C, where modulus of elasticity = 210 GPa and moment of inertia = 3.5 x 10^6 m^4.	**07**
	(b)	Write short note on Hermite Polynomial.	**07**
Q.5	**(a)**	Derive the shape functions for a three-noded bar element using	**07**

polynomial form in local coordinates.

(b) For a four nodded plate element having four nodes at (1,1), (6,2), (6,5) and (1,4) calculate the Jacobean matrix using one point integration. (All dimensions are in meters.) **07**

OR

Q.5 **(a)** Derive the expressions for natural coordinates for a two-noded element in terms of natural coordinate , when range is -1 to 1. **07**

(b) Select a suitable displacement function for a beam element and show that it satisfies the convergence criteria. **07**

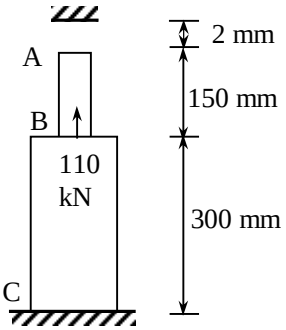

Figure 1

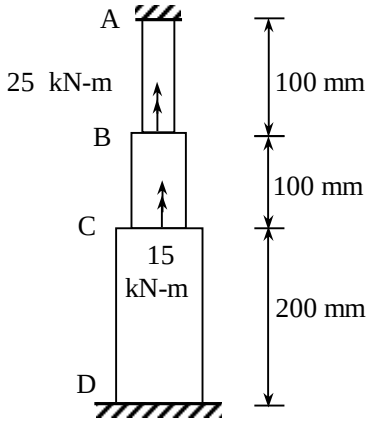

Figure 2

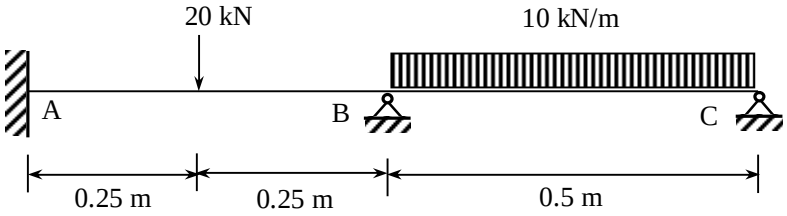

Figure 3