Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII (NEW) EXAMINATION – WINTER 2022

Subject Code:3171920 Date:20-01-2023

Subject Name:Finite Element Methods

Time:10:30 AM TO 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.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	"A few higher order elements are far superior to several lower order elements" Comment on the degree of validity of the statement.	**03**
	(b)	Comment on the statement: "Finite Element Analysis plays a crucial role in the new product development process."	**04**
	(c)	Compare the solution obtained by Galerkin's method with exact solution for X= 0.5 and 1 for the following differential equation. $$\frac{d^2u}{dx^2} + u = x^2; 0 \leq x \leq 1$$ Consider quadratic polynomial function ($u = a_0 + a_1 x + a_2 x^2$).	**07**
Q.2	**(a)**	State the importance of Von Misses Stress distribution.	**03**
	(b)	Explain: Local Coordinates, Global Coordinates, Natural Coordinates and Area Coordinates	**04**
	(c)	Distinguish between essential boundary conditions and natural boundary conditions with suitable examples.	**07**
		OR	
	(c)	Model the tapered bar (as shown in **figure 1**) into two equal elements and derive the global stiffness matrix. Assume E = $200x10^3$ N/mm^2. Also mention the properties of global stiffness matrix.	**07**

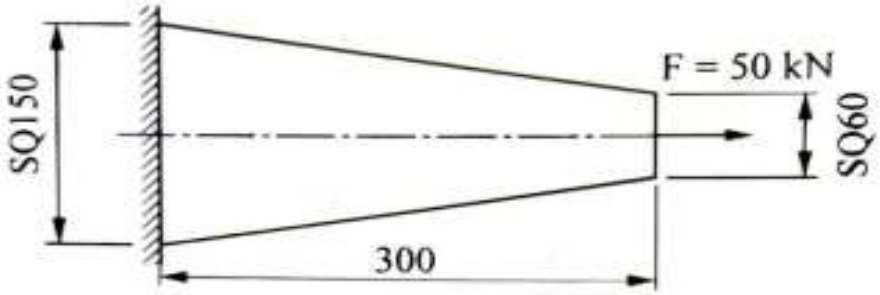

Figure 1

Q.3	**(a)**	Draw different types of 1D, 2D and 3D elements.	**03**
	(b)	Explain, with a sketch, plane stress and plane strain.	**04**
	(c)	Enlist step by step procedure for Finite Element Analysis starting from a given differential equation.	**07**
		OR	
Q.3	**(a)**	Discuss the meshing convergence requirements in FEA.	**03**
	(b)	Discuss the role of interpolation function in FEA and derive shape functions for 1-D linear element.	**04**

(c) Determine the displacements at each node for the given loading conditions as shown in **figure 2**. **07**

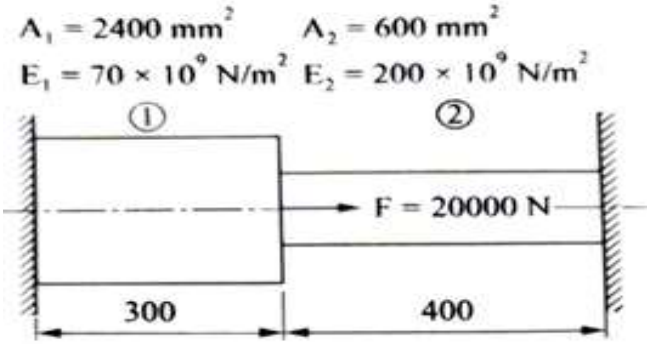

Figure 2

Q.4 **(a)** Explain the concepts of iso, sub and super parametric elements. **03**

(b) Define skyline solutions with its importance. **04**

(c) Write properties of stiffness matrix K. Show the general node numbering scheme and the half bandwidth. **07**

OR

Q.4 **(a)** Write Boundary conditions, force vector and stiffness matrix for Beams. **03**

(b) Evaluate the stress-strain relationship of an Orthotropic materials. **04**

(c) Illustrate the Plane Frames element with neat sketch indicating degree of freedoms. How it is differed from beam element. Write element stiffness matrix K, transformation matrix L and load vector F. **07**

Q.5 **(a)** Discuss discretization process of a given domain based on element shapes, number and size. **03**

(b) Discuss the term CST & LST. **04**

(c) Formulate the additional load vector due to thermal effect in 1D bar elements. **07**

OR

Q.5 **(a)** List out the application of axisymmetric elements. **03**

(b) What are the conditions necessary to be followed for considering a problem as axisymmetric? **04**

(c) A two member truss having 200 mm^2 cross sectional area is subject to a system of forces as shown in **Figure 3**. Determine the nodal displacements in each of the members and consider the modulus of elasticity is 200 GPa. **07**

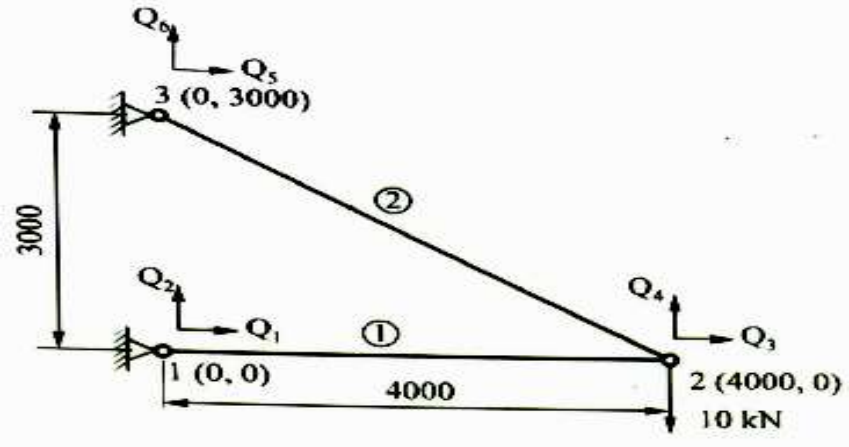

Figure 3