Seat No.: ________ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(NEW) EXAMINATION – SUMMER 2019

Subject Code:2172008 **Date:18/05/2019**

Subject Name:Finite Element Analysis of Mechatronic Systems

Time:02:30 PM TO 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.**

			MARKS
Q.1	**(a)**	Differentiate between plane stress and plane strain.	**03**
	(b)	What are the merits and demerits of FEA as compared to other conventional methods?	**04**
	(c)	Explain general steps of the Finite Element Method in detail.	**07**
Q.2	**(a)**	Explain the significance of performing a Finite element analysis of an engineering problem.	**03**
	(b)	Explain in brief: CST & LST.	**04**
	(c)	Give the derivation of the Stiffness Matrix for a Bar Element in Local Coordinates.	**07**
		OR	
	(c)	For the spring assemblage shown in Figure 2, obtain (a) the global stiffness matrix, (b) the displacements of nodes 2–4, (c) the global nodal forces, and (d) the local element forces. Node 1 is fixed while node 5 is given a fixed, known displacement d=20.0mm. The spring constants are all equal to k = 200 kN/m.	**07**

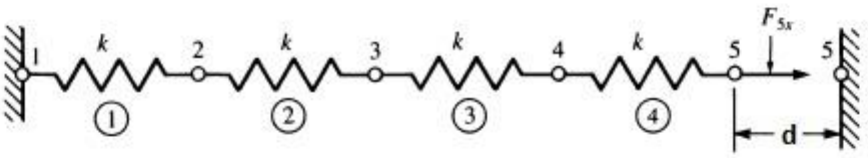

Figure 2

Q.3	**(a)**	Explain the different types of Elements used in Finite Element Analysis.	**03**
	(b)	Explain the significance of the following terms related to a Finite Element Problem 1. Approximation function 2. Boundary conditions	**04**
	(c)	For the bar element shown in Figure 3, evaluate the global stiffness matrix with respect to the x-y coordinate system. Let the bar's cross-sectional area equal 2 inch^2,length equal 60 inch, and modulus of elasticity equal 30 x 10^6 psi. The angle the bar makes with the x axis is 30°.	**07**

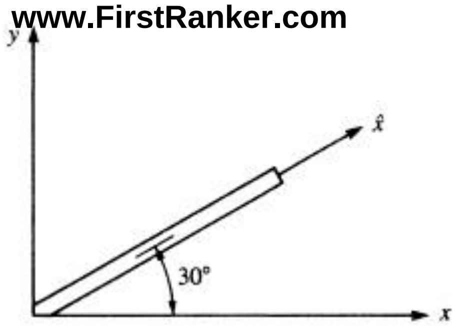

Figure 3

OR

Q.3 **(a)** Give name of different types of 1D element with their applications. **03**

(b) Give four examples of practical application of axisymmetric element. **04**

(c) For the two-bar truss shown in Figure 4, determine the displacement in the y direction of node 1 and the axial force in each element. A force of P=1000 KN is applied at node 1 in the positive y direction while node 1 settles an amount d = 50 mm in the negative x direction. Let E = 210 GPa and A = 6.00 x 10^{-4} m^2 for each element. The lengths of the elements are shown in the figure. **07**

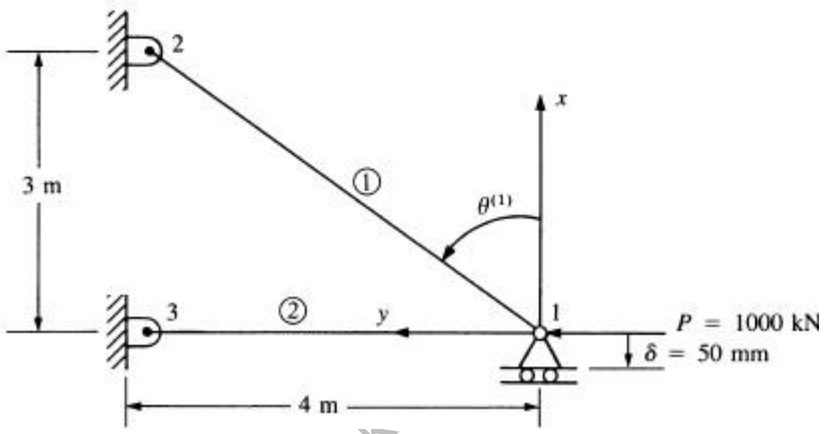

Figure 4

Q.4 **(a)** Explain the different types of nonlinearities. **03**

(b) Explain evaluation eigenvectors in dynamic consideration. **04**

(c) Give Potential Energy Approach to Derive Beam Element Equations. **07**

OR

Q.4 **(a)** Write down the expression of shape function N and displacement u for one dimensional bar element. **03**

(b) Explain evaluation of eigenvalues in dynamic consideration. **04**

(c) Determine the nodal displacements and rotations and the global and element forces for the beam shown in Figure 5. We have discretized the beam as shown by the node numbering. The beam is fixed at node 1, has a roller support at node 2, and has an elastic spring support at node 3. A downward vertical force of P = 50 kN is applied at node 3. Let E = 210 GPa and I = 2 x 10^{-4} m^4 throughout the beam, and let k = 200 kN/m. **07**

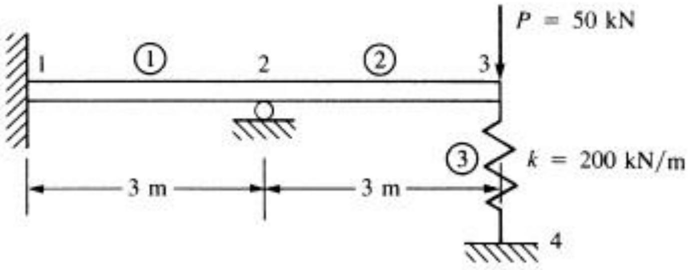

Figure 5

Q.5	**(a)**	Differentiate between dynamics and statics in FEA.	**03**
	(b)	Define the terms with suitable examples: Isoparametric element.	**04**
	(c)	Give the derivation of the Linear-Strain Triangular Element Stiffness Matrix and Equations.	**07**

OR

Q.5	**(a)**	Differentiate between spring, bar and beam elements from general and application point of view.	**03**
	(b)	Evaluate: Higher number of elements leads to getting a solution closer to the exact one.	**04**
	(c)	Establish the shape functions and derive the strain displacement matrix for an axisymmetric triangular element.	**07**

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