Seat No.: _____  Enrolment No. 

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER– VII (New) EXAMINATION – WINTER 2019**

**Subject Code: 2172008** **Date: 30/11/2019**

**Subject Name: Finite Element Analysis of Mechatronic Systems**

**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.**

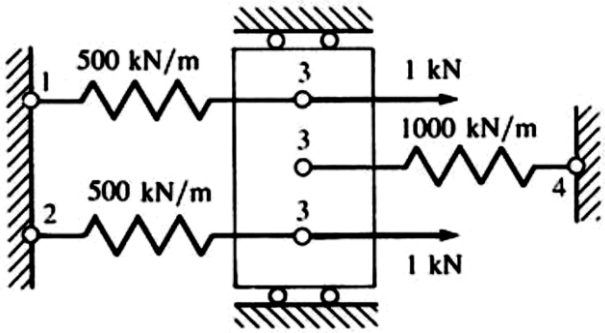
**Q.1** **(a)** Define FEA? List the advantages of using Finite Element Analysis **03**

**(b)** What do you understand by Discretization? Discuss the factors to be considered for discretizing the domain. **04**

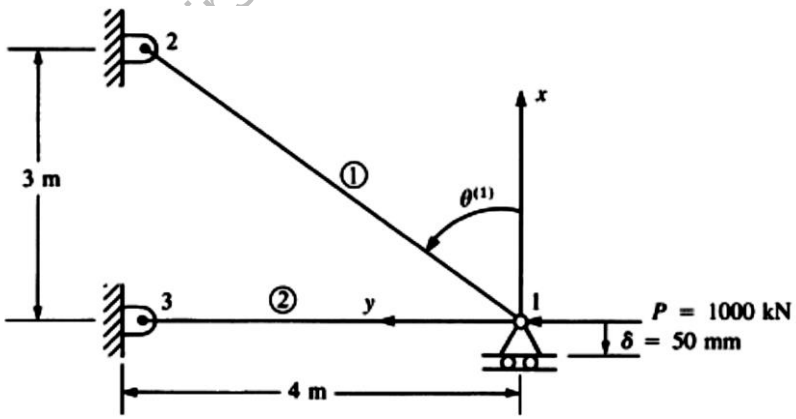
**(c)** Discuss the importance of a shape function. Derive the shape function for a spring element highlighting its significance. **07**

**Q.2** **(a)** Discuss the applications of Finite Element Method. **03**

**(b)** Using potential energy approach find the nodal displacements, forces in each element and the reactions for the spring assemblage shown in below figure **04**

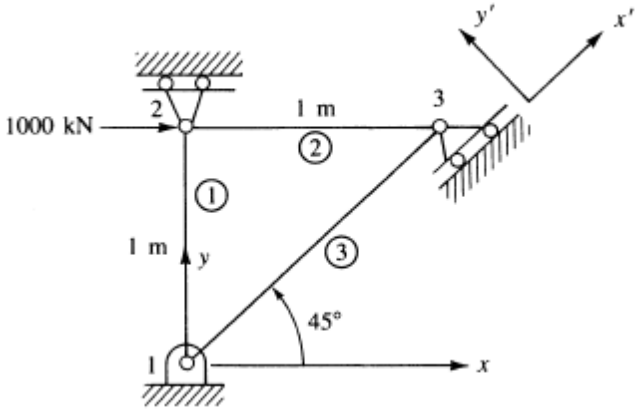



**(c)** For the two-bar truss shown in Figure, determine the displacement in the y direction of node 1 and the axial force in each element. Let E = 210 GPa and A = 6 x $10^{-4}$ $m^2$ for each element. The lengths of the elements are shown in the figure. **07**




**OR**

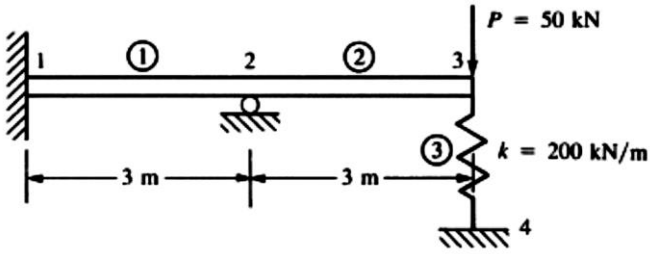
**(c)** For the plane truss shown in Figure, determine the displacements and reactions. Let E = 210 GPa, A = 6 x $10^{-4}$ $m^2$ for elements 1 and 2, and A = 6 √2 x $10^{-4}$ $m^2$ for element 3. **07**




**Q.3** **(a)** Discuss the conditions necessary for solving a problem using Axisymmetric element. **03**

**(b)** List and explain the rules for selecting a displacement function. **04**

**(c)** Determine the nodal displacements and rotations and the global and element forces for the beam shown in Figure. 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 $10^{-4}$ $m^4$ throughout the beam, and let k = 200 kN/m. **07**

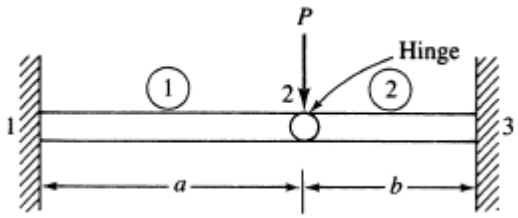



**OR**

**Q.3** **(a)** "Understanding computer aided design is mandatory for FEA". Evaluate **03**

**(b)** Discuss the different types of elements used for discretization with specific examples and applications. **04**

**(c)** Determine the displacement and rotation at node 2 and the element forces for the uniform beam with an internal hinge at node 2 shown in Figure. Let EI be a constant. **07**




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

**(b)** Discuss the role of dynamics in analyzing structures using FEA. **04**

**(c)** Compare and Contrast: Plane stress and Plane strain conditions with suitable example. **07**

**OR**

**Q.4** **(a)** State and explain different types of boundary conditions used in FEA **03**

**(b)** Explain the principle of minimum potential energy with a suitable example. **04**

**(c)** Discuss the Isoparametric formulation for a bar element **07**

**Q.5** **(a)** During discretization, mention the places where it is necessary to place a node. Justify your answer **03**

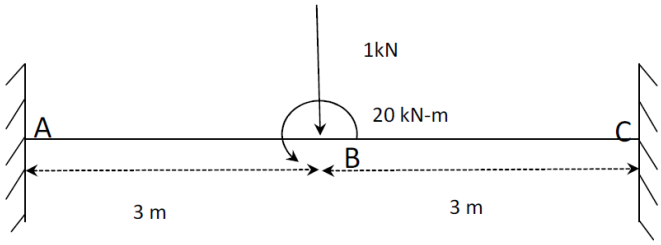
- Concentrated load acting point
- Cross-section changing point
- Different material inters ections

**(b)** State whether plane stress or plane strain elements can be used to model the following structures. Justify your answer. **04**

a) A wall subjected to wind load

b) A wrench subjected to a force in the plane of the wrench.

**(c)** Given that E=210 GPa and $I=4\times10^{-4}$ $m^4$, cross section of the beam is constant. Determine the deflection and slope at point B. calculate the reaction forces and moments. **07**




**OR**

**Q.5** **(a)** Explain Constant Strain Triangle. **03**

**(b)** FEA leads to obtaining an approximate solution. Explain. **04**

**(c)** Discuss the differences between CST and LST with examples. **07**

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