Name: **Enrolment No:**	

UPES

End Semester Examination, December 2024

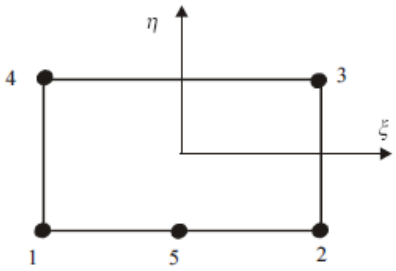
Course: Finite Element Analysis **Semester: VII**

Program: B. Tech Aerospace **Time : 03 hrs.**

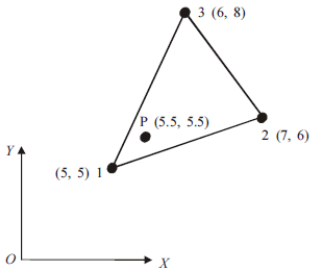
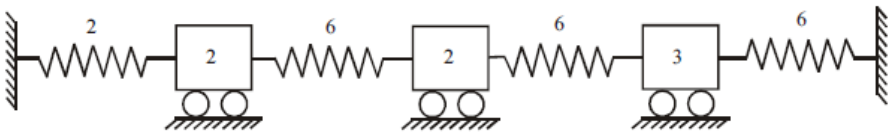
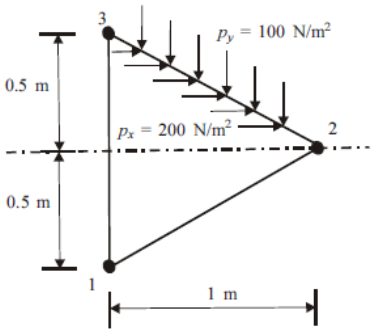
Course Code: MECH4023 **Max. Marks: 100**

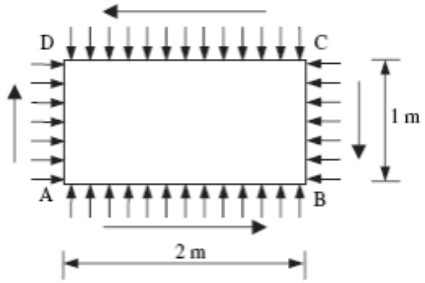
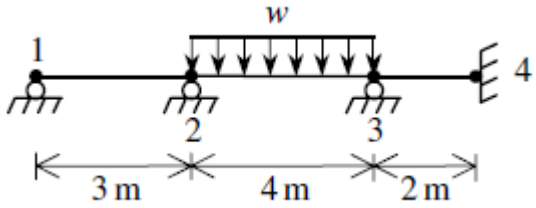
Instructions: ***All questions are compulsory. The question paper consists of 11 questions divided into 3 sections A, B and C. Section A comprises 5 questions of 4 marks each, Section B comprises 4 questions of 10 marks each and Section C comprises 2 questions of 20 marks each.***

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Write all the shape functions for the element shown in figure. 	**4**	**CO1**
Q 2	Discuss plain stress and plain strain condition?	**4**	**CO2**
Q 3	Identify the shape functions of 3 nodded CST element?	**4**	**CO1**
Q 4	Discuss the purpose of Natural Coordinate System?	**4**	**CO1**
Q 5	Explain the significance of Jacobian in terms of natural and global coordinate system?	**4**	**CO1**

SECTION B
(4Qx10M= 40 Marks)

Q 6	For the three nodded triangular element shown in figure, calculate the temperature at point P, given the nodal temperature as $T_1 = 100^oC, T_2 = 200^0C \; and \; T_3 = 300^oC.$  	**10**	**CO2**
Q 7	Write down the stiffness and mass matrices of the structure shown below:  	**10**	**CO2**
Q 8	Identify the strain displacement matrix for CST Element?	**10**	**CO2**
Q 9	Identify shape function for four nodded quadrilateral elements? Discuss the transformation of global coordinate system into natural coordinate system?	**10**	**CO2**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	Determine the consistent load vector for the CST element under the action of the loading shown in figure.  **OR** Consider a rectangular panel as shown in Figure. The panel is modeled using a plane stress linear elastic material with the following properties: Young's modulus E = 3 × 10^{11} Pa and Poisson's ratio υ = 0.3. The essential boundary conditions are $u_{Ax} = u_{Ay} = u_{By} = 0$. The natural boundary conditions are as follows. Along each edge of the panel, the	**20**	**CO3**

	prescribed traction consists of normal and lateral components, both equal to 10^3 N/m. Discretize the panel using a single rectangular element as shown below. For convenience, use identical global and local numberings as shown in Figure. Calculate nodal displacements and stresses at the element Gauss points.  		
Q 11	Consider the beam shown in Figure, Given E = 210 GPa, I = 60×10^{-6} m^4, P = 20 kN, and L = 2m, determine: 1. the global stiffness matrix for the structure. 2. the vertical displacement at node 2. 3. the rotations at nodes 2 and 3. 4. the reactions at nodes 1 and 3. 5. the forces (shears and moments) in each element. 	**20**	**CO3**