U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

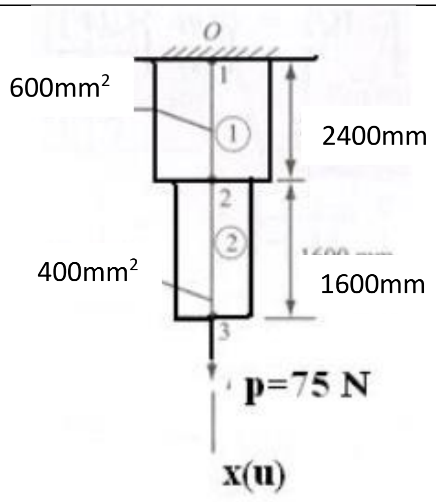
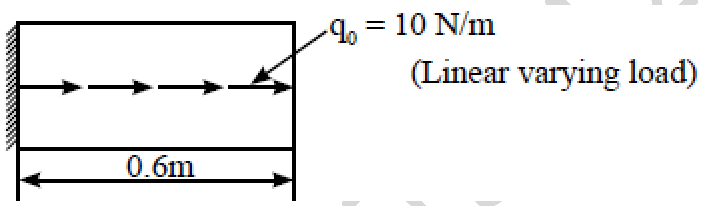
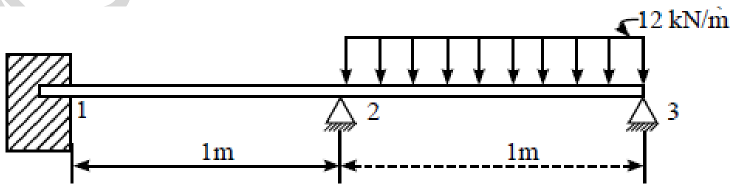
January 2024 Semester End Main Examinations

Programme: B.E. **Semester: VII**
Branch: Institutional Elective **Duration: 3 hrs.**
Course Code: 21CV7OEFEA **Max Marks: 100**
Course: FINITE ELEMENT ANALYSIS

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	The state of stress at a point is given by $\sigma ij =$ $\begin{bmatrix} 250 & 180 & -150 \\ 180 & -260 & 110 \\ -150 & 110 & 180 \end{bmatrix}$ kN/m^2. Determine the strain tensor at the point. Take E = 200 x 10^6 kN/m^2 and μ = 0.3.	C01	P01	**08**
	b)	Write the stress - strain relationship for both plane stress and plane strain problems (derivation not required).	C01	P01	**04**
	c)	What is FEM? Discuss the types of elements based on geometry.	C01	P01	**08**
		UNIT - II			
2	a)	Write the properties of stiffness matrix and derive the element stiffness matrix (ESM) for a 1D bar element (derivation of shape function is not required).	C02	P01	**10**
	b)	Identify and sketch indicating the degrees of freedom of the bar element to be used in the analysis of stepped bar shown in Fig.1 A_1 = 600mm^2, A_2 = 400 mm^2, L_1 = 2400 mm and L_2 = 1600 mm. Calculate Nodal Displacements and Stresses. Young's Modulus (E) = 2 x 10^{11} N/m^2. Estimate the new displacement field caused considering self-weight also. ρ =7848 kg/m^3	C02	P01, P02	**10**

			 **Fig. 1**			
			OR			
	3	a)	Find the nodal displacement, stress and strain of the system shown in Fig. 2. Take E = 70 GPa, Area = 1.0 m^2.  **Fig. 2**	*C02*	*P01, P02*	**10**
		b)	Describe the functions of the pre-processor, solver/processor, and post-processor within the context of a commercial finite element package.	*C01*	*P01*	**06**
		c)	What requisites of the convergence criteria?	*C01*	*P01*	**04**
			UNIT - III			
	4		For the beam and loading shown in Fig 3, determine the slopes at 2 and 3. Draw BMD and elastic curve. Take E = 200 GPa, I = 4 x $10^6 mm^4$.  **Fig. 3**	*C02*	*P01, P02*	**20**
			OR			
	5	a)	Derive Hermite shape function and stiffness matrix for a beam element.	*C02*	*P01*	**10**
		b)	For the two-bar truss shown in Fig. 4, construct the finite element model. Determine the nodal displacements and compute the element forceses.	*C02*	*P01, P02*	**10**

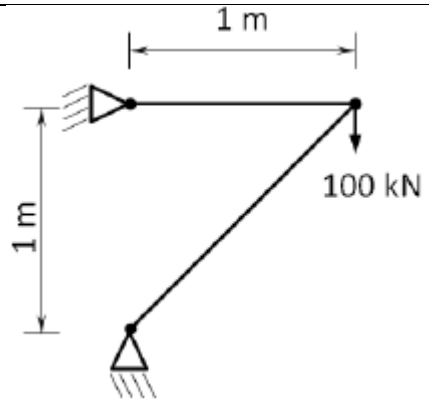


Fig. 4

			UNIT - IV			
6	a)	A modal co-ordinate of the triangular is shown in Fig. 5. At the interior point 'P' the co-ordinate is (3.3, y) and N1 = 0.3. Determine 'N2' and 'N3' and the y co-ordinate at point P.	*C03*	*P01*	**04**
	b)	Compute the strain displacement matrix for the element shown in Fig. 6. Also determine the element strains. All dimensions are in mm. Nodal displacement vector in mm {q} = [0.002, 0.001, 0.001, -0.004, -0.003, 0.007}^{T}	*C03*	*P01*	**08**

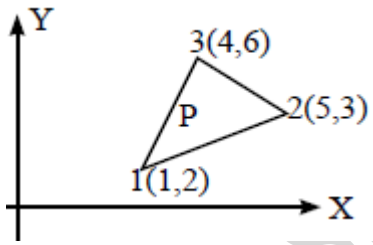
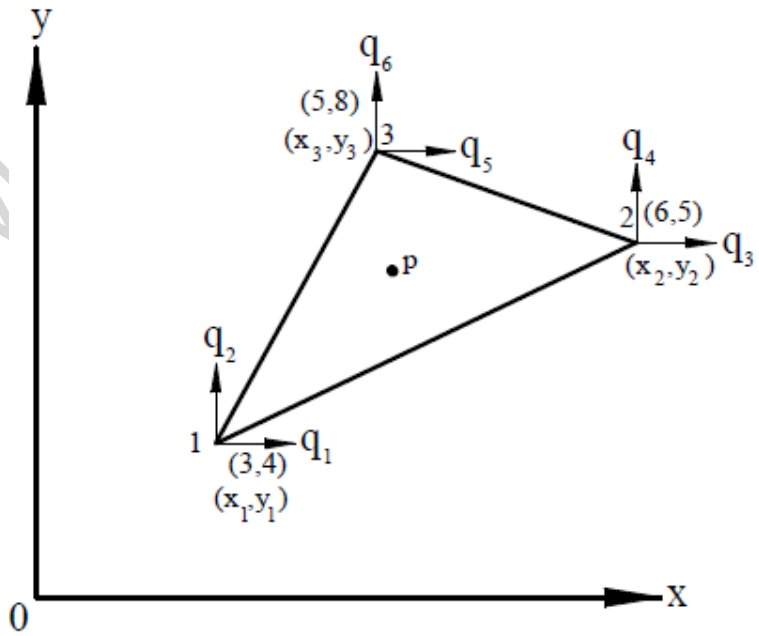
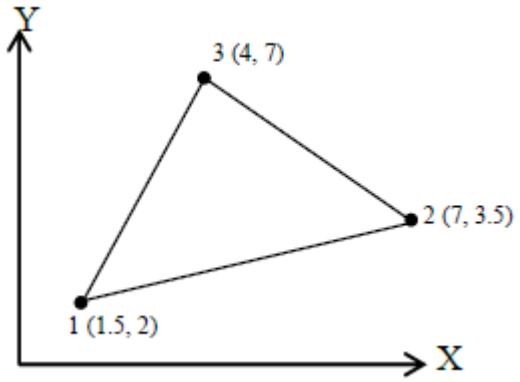


Fig. 5

Fig. 6



		c)	Determine the 'Jacobian' for the triangular element shown in Fig.7  **Fig. 7**			**08**
			UNIT - V			
	7	a)	A four-noded quadrilateral element has coordinates 1 (10, 10), 2 (50, 10), 3 (60, 60) and 4 (10, 40). If the element nodal displacement vector is given by $\{q\} = \{0, 0, 1, 2, 0, 1.5, 1, 0\}$ mm, determine (i) the x & y coordinates of point P which has $\xi = 0.5$ and $\eta = 0.5$ and (ii) displacements u & v of the point P.	*C03*	*P01*	**08**
		b)	Derive Jacobian matrix for a linear Quadrilateral element.	*C03*	*P01*	**06**
		c)	Differentiate between isoparametric, subparametric and super-parametric elements.	*C03*	*P01*	**06**

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