U.S.N.										

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

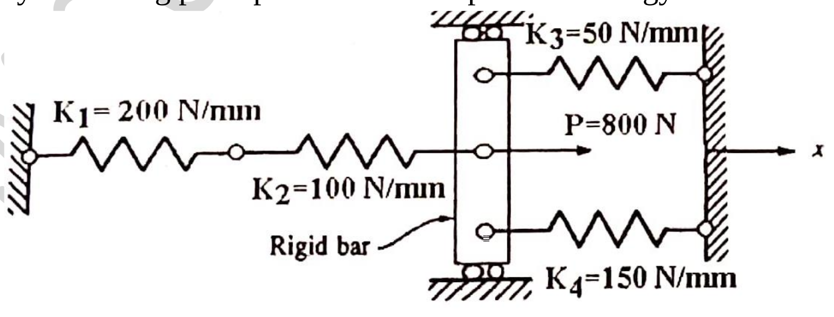
Autonomous Institute Affiliated to VTU

May 2024 Semester End Make-Up Examinations

Programme: B.E. — **Semester: V**
Branch: Mechanical Engineering — **Duration: 3 hrs.**
Course Code: 22ME5PCMFE — **Max Marks: 100**
Course: Modelling and 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)	Write the following in matrix form: i) Equilibrium equations in 3D ii) Strain-displacement relations in 3D iii) Stress-strain relations in 3D iv) Stress-strain relations for Plane stress condition	*CO1*	*PO1* *PO2*	**08**
	b)	Using the Rayleigh-Ritz method, obtain an expression for deflection of a simply supported beam with a point load at the centre.	*CO1*	*PO1* *PO2*	**10**
	c)	Citing example, differentiate essential and non-essential boundary conditions.	*CO1*	*PO1* *PO2*	**02**
		OR			
2	a)	Determine the nodal displacements for the following spring system using principle of minimum potential energy. 	*CO1*	*PO1* *PO2*	**10**
	b)	Evaluate the following integral with suitable Gauss quadrature. Verify the answer with analytical solution. $$I = \int_0^3 (1 + 2r + 3r^2 + 4r^3)dr$$	*CO1*	*PO1* *PO2*	**08**
	c)	Define principle of Minimum Potential Energy.	*CO1*	*PO1*	**02**

			UNIT - II			
	3	a)	Formulate the element stiffness matrix for a 2-noded bar element with 1 dof at each node.	*CO2*	*PO1* *PO2*	**08**
		b)	Determine displacement field, support reaction and stresses for the stepped bar shown in fig 3b. A_{AL} = 40 mm^2, E_{AL} =70x10^3 N/mm^2, A_{ST} = 20 mm^2, E_{ST} =200x10^3 N/mm^2.	*CO2*	*PO1* *PO3*	**12**

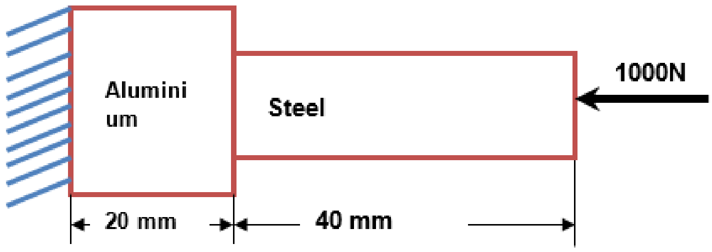
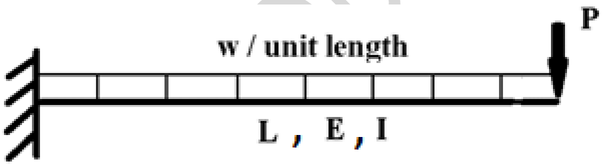


Figure 3b

			UNIT - III			
	4	a)	Derive the element stiffness matrix for 2-noded plane truss element.	*CO3*	*PO1* *PO2*	**06**
		b)	For the beam loaded as shown in Figure 5b, determine the nodal unknowns and reactions. E=200 GPa, I=10x10^{-4} m^4. Take L=3m, w=10N/m, P=50kN	*CO3*	*PO1* *PO2*	**14**



			UNIT - IV			
	5	a)	The nodal coordinates of the triangular element are shown in figure 6a below. At point P inside the element, x coordinate is 3.3 and the shape function N_1=0.3. Determine the shape functions N_2, N_3 and the Y coordinate of point P.	*CO4*	*PO1* *PO2*	**08**

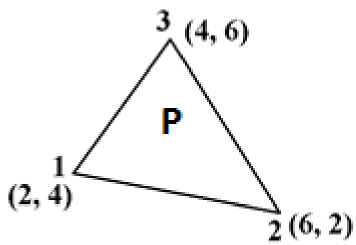
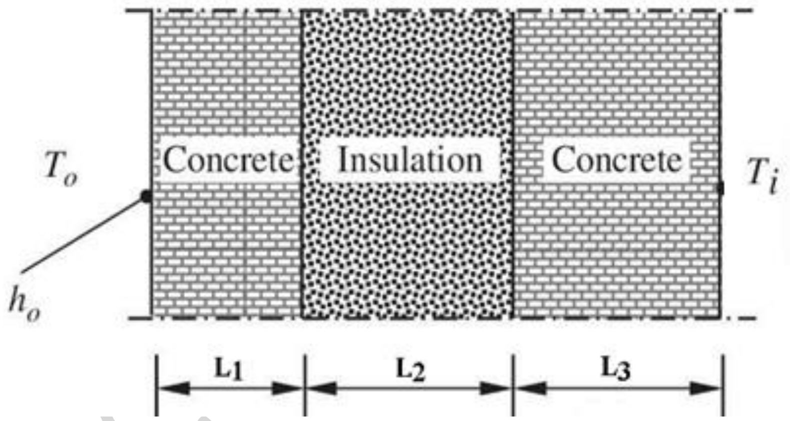


figure 6a

		b)	Sketch 2D constant strain element indicating the degrees of freedom. Obtain expressions: i) Shape functions, ii) Jacobian & iii) Strain-displacement matrix	*CO4*	*PO1* *PO2*	**12**

			OR			
	6	a)	Formulate shape functions for Quadratic Bar Element.	*CO4*	*PO1* *PO2*	**06**
		b)	Sketch 9-noded quadrilateral element and Write the shape functions for the same.	*CO4*	*PO1*	**08**
		c)	Discuss Iso, Sub and Super-parametric elements.	*CO4*	*PO1*	**06**
			UNIT - V			
	7	a)	Derive shape functions for 2-noded one-dimensional heat transfer element in global coordinates.	*CO4*	*PO1* *PO2*	**06**
		b)	Consider a wall built up of concrete and thermal insulation as shown in figure Q 7b. The outdoor temperature is T_0= - 15 ^{0}C, and the temperature inside is T_i= 30 ^{0}C. The wall is subdivided into three layers as shown. The thermal conductivity for concrete is K_c= 2 W/m^{0}C and that of the insulator is K_i=0.05 W/m^{0}C. Convection heat transfer is occurring at outer surface with convection coefficient of h_0=24 W/m^2 ^{0}C. Determine the temperature distribution across the wall. Take L_1=5 cm, L_2=25 cm, and L_3=50 cm.  figure Q 7b	*CO4*	*PO1* *PO2*	**14**

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