U.S.N.										

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

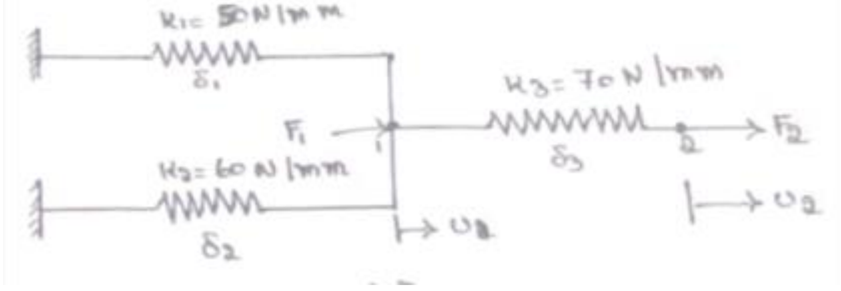
Autonomous Institute Affiliated to VTU

September / October 2024 Supplementary Examinations

Programme: B.E. **Semester: VI**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 20ME6DCMFE **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)	A sealed plastic Coke-Can containing coke juice under pressure as shown in Fig. 1.a. is to be analysed for stresses in its wall (radial, hoop and axial stresses). Can this be modelled as a Plane stress case? If Yes, Justify your answer. If No, then which 2D case can be used and why? Also write the corresponding constitutive relation.  Fig 1.a	*CO1*	*PO2*	**05**
	b)	Evaluate the following integral using two and three point Gauss quadrature I= $\int_{-1}^{1}(0.2+25x-200x^2+675x^3-900x^4+400x^5)dx$	*CO1*	*PO2*	**05**
	c)	With a neat sketch, derive the equations of equilibrium in case of a three- dimensional stress system.	*CO1*	*PO1*	**10**
		OR			
2	a)	Calculate the nodal displacements for the following spring system using principle of minimum potential energy for the Fig.2a shown below .Take F1=75 N,F2=100 N  Fig.2a	*CO1*	*PO2*	**08**

	Q. No.	Sub	Question	CO	PO	Marks
		b)	Using Galerkin method, derive the expression for displacement of a bar that is subjected to distributed axial load P_o per unit length. The bar is fixed at x= 0 and free at x = L, where L is the length of the bar.	*CO1*	*PO2*	**12**
			UNIT – II			
	3	a)	List the properties of stiffness matrix of an element.	*CO2*	*PO1*	**04**
		a)	Determine the nodal displacements and reaction forces for the stepped bar system shown in figure 3 b, for a temperature rise from 15° to 95°. Also write: i) Finite Element model showing node and element numbers ii) Element stiffness matrices iii) Global stiffness matrix iv) Element thermal load vectors v) Global thermal load vector vi) Global load vector vii) Specify the displacement boundary conditions viii) Global equilibrium equations viii) Check for the force equilibrium	*CO2*	*PO2*	**16**

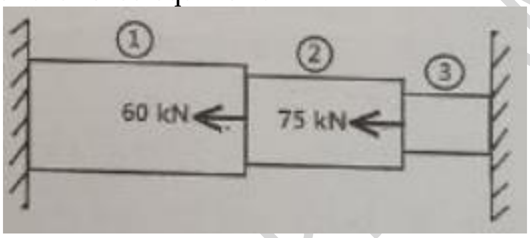


Fig 3. b

Region	1	2	3
Length(mm)	800	600	400
Cross sectional area(mm^2)	2400	1200	600
Youngs Modulus(GPa)	83	70	200
Coeff. Of Thermal Expansion,($*10^{-6}/^oC$)	18.9	23	11.7

	Q. No.	Sub	Question	CO	PO	Marks
			UNIT – III			
	4	a)	Explain the need for Hermitian shape functions for 2-noded beam element. Write all the Hermitian shape functions.	*CO3*	*PO1*	**06**
		b)	For a plane truss shown in Fig. 4b determine the horizontal and vertical displacement at the nodes and the stress in each elements having E=201 GPa and A= $4*10^{-4}m^2$.	*CO3*	*PO2*	**14**

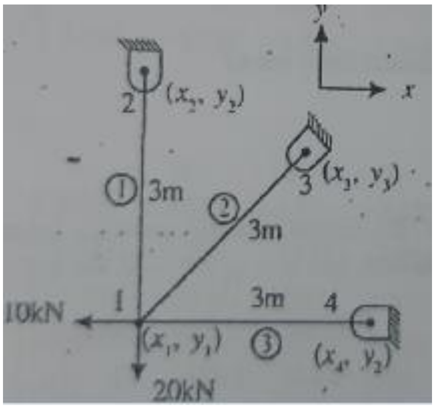


Fig.4b

			UNIT – IV			
	5	a)	Derive shape functions and strain-displacement matrix for constant strain 2D simplex element.	*CO3*	*PO1*	**12**
		b)	Compute the strain displacement matrix for the element shown in Fig 5b. Also determine the element strains. All dimensions are in Nodal displacement vector in mm (q)= (0.002,0.001,0.001,-0.004,-0.003,0.007)mm.	*CO3*	*PO2*	**08**

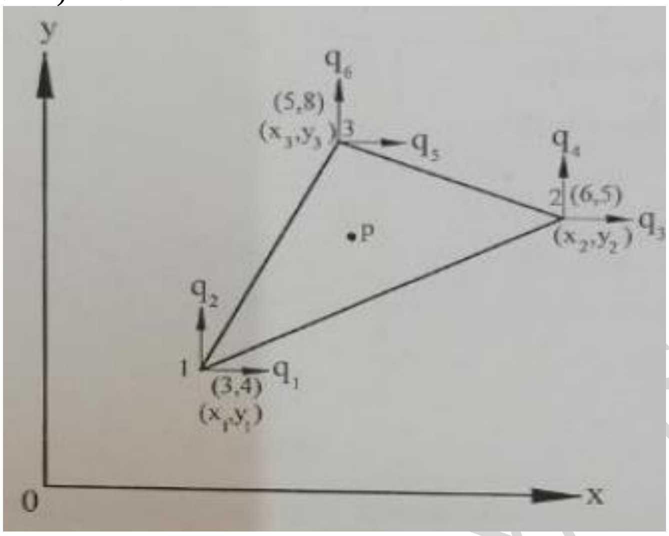
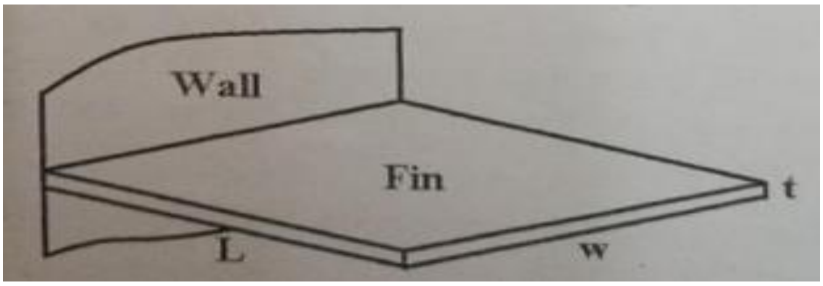


Fig.5b

			OR			
	6	a)	State the convergence criteria to be satisfied by displacement functions	*CO4*	*PO1*	**05**
		b)	Distinguish with example Lagrange and Serendipity family of elements.	*CO4*	*PO1*	**06**
		c)	An axisymmetric body rotates with a constant rpm of 1000. In the FEA mesh, a 3-noded triangular element has nodal coordinates (r, z) in mm as 1(50,50), 2(80,50) and 3(50,75). Estimate the body force vector considering the weight of the material, if the mass density is 7860 kg/m³.	*CO4*	*PO2*	**09**
			UNIT – V			
	7	a)	A composite wall of a chemical processing unit consists of two layers of materials. The surface temperature of the outer surface of the outer layer (thickness= 0.06m, K= 6 W/m°C) is 20°C. Convection heat loss occurs at the inner surface of the inner layer (thickness= 0.02m, K= 20 W/m°C) with a convective heat transfer coefficient of 1000 W/m² °C and bulk temperature of -5°C. Assuming area of conductive heat transfer as 1m², determine the temperature distribution across the wall and heat flux in each layer.	*CO4*	*PO2*	**10**
		b)	A metallic fin with thermal conductivity K= 360 W/m °C, having length L= 0.1m, width w= 1m and thickness t= 0.001m as shown in figure 7 b extends from a plane wall whose temperature is 235°C. Assuming the tip of the fin to be insulated, all other surfaces are exposed to surrounding air which is having a	*CO4*	*PO2*	**10**

			convective heat transfer coefficient of 9 W/m²°C and a bulk temperature of 20 °C, construct a 3-element model and determine the temperature distribution across the fin.  Fig 7.b.			

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