U.S.N.										

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

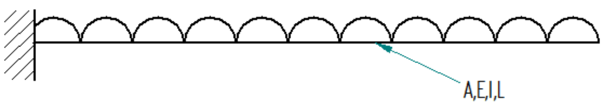
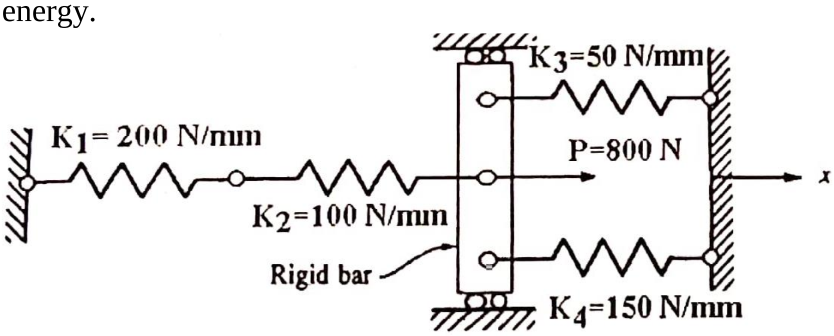
Autonomous Institute Affiliated to VTU

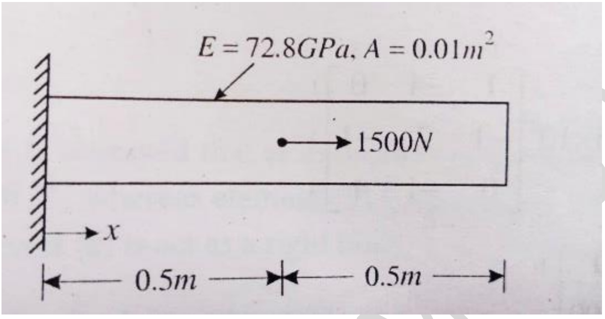
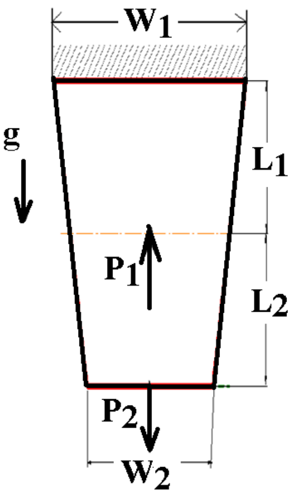
June / July 2025 Semester End Main Examinations

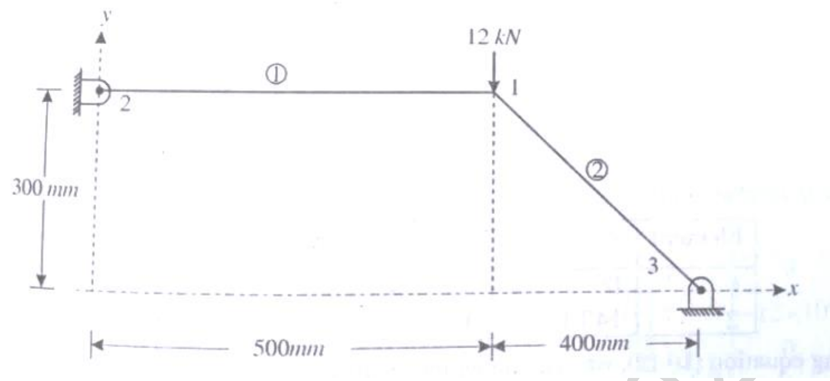
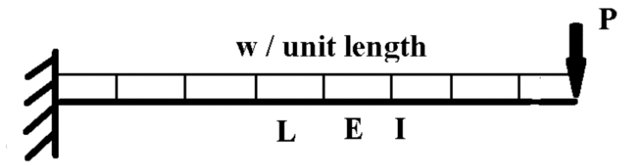
Programme: B.E. | **Semester: V/VI**
Branch: Mechanical Engineering. | **Duration: 3 hrs.**
Course Code: 22ME5PCMFE | **Max Marks: 100**
Course: Modeling and Finite Element Analysis

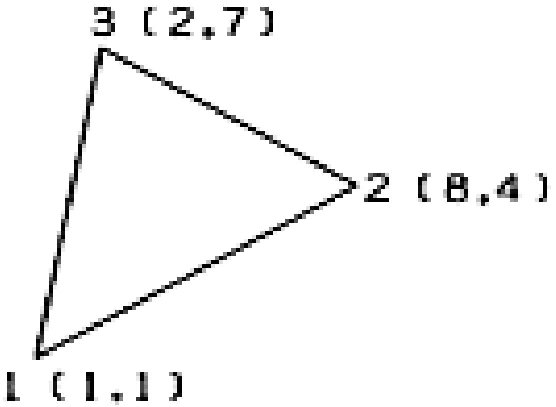
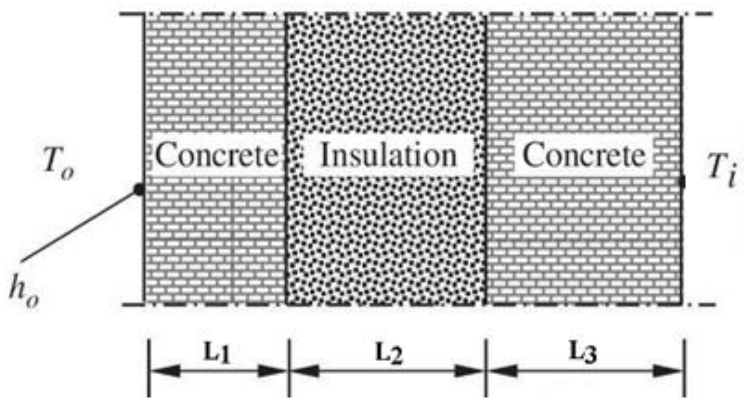
Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

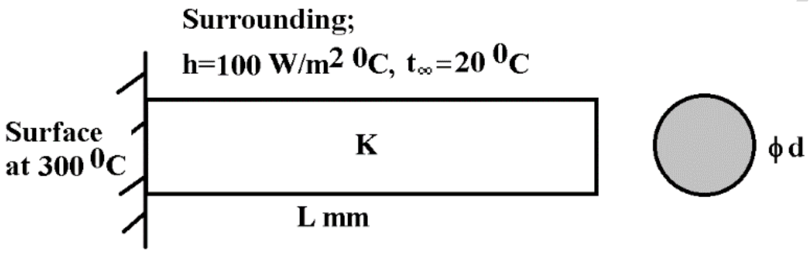
Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	*CO*	*PO*	**Marks**
1	a)	Write the following in the matrix form i. 3D-Strain displacement relation, ii. Equilibrium equations. iii. stress-strain relationship for plane stress condition iv. stress-strain relationship for plane strain condition	*CO1* *CO2*	*PO1*	**08**
	b)	Formulate transverse displacement for a cantilever beam subjected to UDL over entire length for the beam shown in Fig. 1b, using Rayleigh-Ritz method.  Fig. 1b	*CO2*	*PO2*	**12**
		OR			
2	a)	Determine the nodal displacements for the following spring system shown in Fig. 2a using principle of minimum potential energy.  Fig. 2a	*CO1* *CO2*	*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* *CO2*	*PO2*	**06**
	c)	With example, differentiate essential and non-essential boundary conditions.	*CO1* *CO2*	*PO1*	**04**
		UNIT - II			
3	a)	Formulate the element stiffness matrix for a 2-noded bar element.	*CO1* *CO2*	*PO1*	**08**
	b)	A bar is subjected to axial load 1500 N at the mid length as shown in Fig. 3b. Determine the displacement at load point and comment on the strain and stress in the bar  Fig. 3b	*CO1* *CO2*	*PO2*	**12**
		OR			
4	a)	Derive Shape functions for 2-noded bar element using natural coordinate system	*CO2*	*PO1* *PO3*	**06**
	b)	For the problem shown in Fig. 4b, Determine the nodal displacements, element stresses and reactions. Thickness of the plate=5 mm, W_1=50 mm, W_2=30 mm. Density=8000 kg/m^3 and E=100 GPa. Where L_1= L_2=1.5 m, P_1=P_2=70 kN.  Fig. 4b	*CO4* *CO6*	*PO1* *PO2*	**14**

			UNIT - III			
	5	a)	Derive Hermitian shape functions for a beam and sketch their variation in physical form	CO2 CO3	PO1 PO2	**08**
		b)	Obtain displacements at node 1, reactions at nodes 2 and 3, and stresses and strains in the truss shown in Fig. 5b take E=70 GPa, A =200 mm^2  Fig. 5b	CO2 CO3	PO1 PO2	**12**
			OR			
	6	a)	Derive the element stiffness matrix for 2 noded plane truss element.	CO2	PO1	**06**
		b)	For the problem shown in Fig. 6b, determine the nodal deflections and reactions. E=200 GPa, I=$10x10^{-4}$ m^4. Take L=3m, w=10 N/m, P=50 kN.  Fig. 6b	CO2 CO3	PO2	**14**
			UNIT - IV			
	7	a)	Sketch 2D constant strain triangular element indicating the degrees of freedom and derive expressions for the following I. shape functions, II. Jacobian & Strain displacement matrix	CO2 CO3	PO2	**12**
		b)	For the triangular element shown in Fig. 7b, determine the strain ε_x, ε_y and γ_{xy}. Given, displacements q_1 = 0.001, q_2 = -0.004, q_3 = 0.003, q_4 = 0.002, q_5 = -0.002 and q_6 = 0.005.	CO2 CO3	PO2	**08**

			 Fig.7b			
			OR			
	8	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			
	9	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. 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 in Fig. 9b. 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. Calculate the temperature distribution in the wall. Take L_1=5 cm, L_2=25 cm, L_3=50 cm.  Fig. 9b	*CO4*	*PO1* *PO2*	**14**

			OR			
	10	a)	Derive shape function for 2-noded one-dimensional heat transfer element in Natural coordinates system	*CO4*	*PO1* *PO2*	**06**
		b)	Determine the temperature distribution and amount of heat transfer in a rectangular fin shown in Fig. 10b. Use two 2-noded 1-D heat transfer elements. Also obtain the temperature at mid-point of the 1st element. Assume that the end face of the fin is insulated. L=0.05 m, d=0.01 m, K=50 W/m^{0}C  Fig. 10b.	*CO4*	*PO1* *PO2*	**14**

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