U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: V/VI**

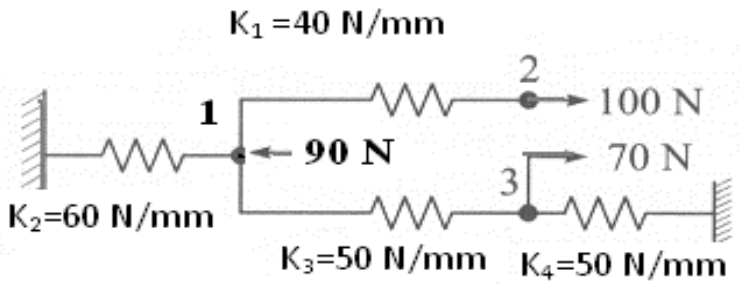
Branch: Mechanical Engineering **Duration: 3 hrs.**

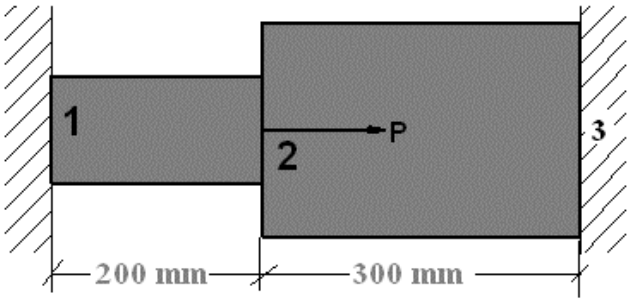
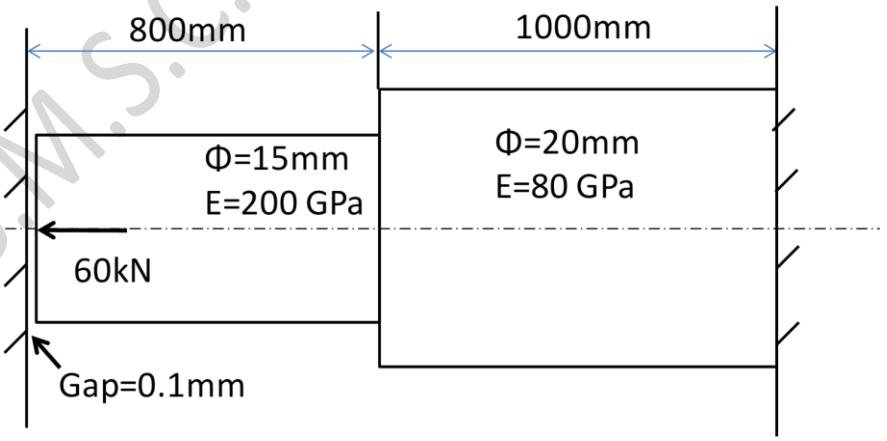
Course Code: 23ME6PCMFE/22ME5PCMFE/20ME6DCMFE **Max Marks: 100**

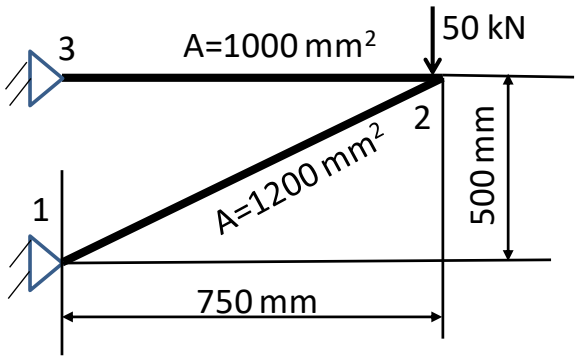
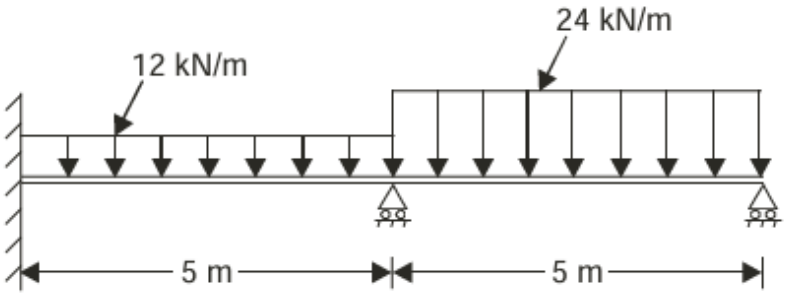
Course: Modeling and Finite Element Analysis

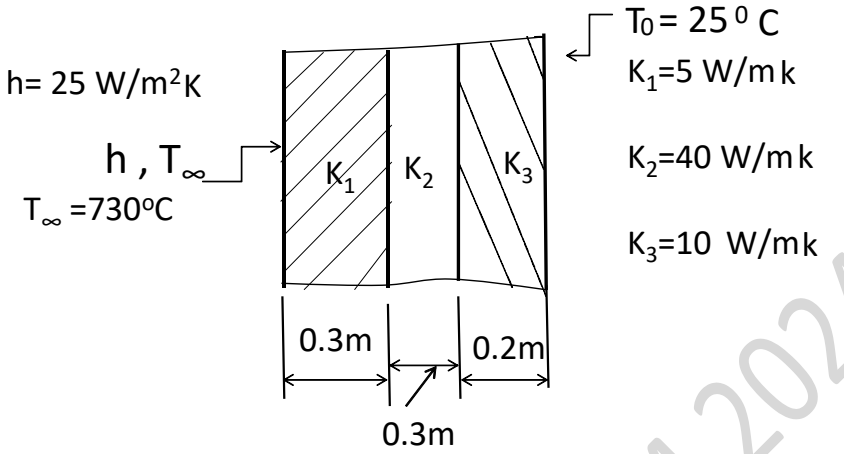
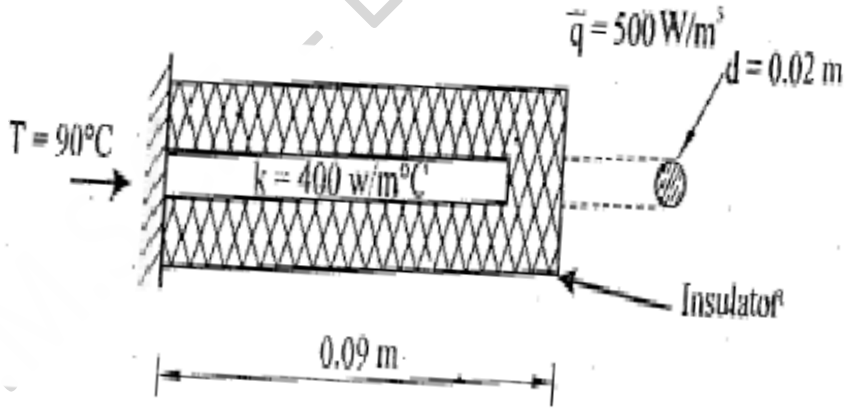
Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

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)		Differentiate plane stress and plane strain idealization with relevant sketch and equations.	*CO1*	*PO1*	**06**
	b)		Derive the equations of equilibrium for 2- dimensional loading.	*CO1*	*PO2*	**07**
	c)		For the following spring system shown in Figure-1, estimate the displacements at nodes 1, 2 & 3.  Figure-1	*CO1*	*PO2*	**07**
			OR			
2	a)		Using Rayleigh-Ritz method, estimate the deflection in a beam of length 'L' fixed at both the ends and applied with an UDL of Po N/mm through the length. Young's modulus is E and Inertia is I.	*CO1*	*PO2*	**12**
	b)		Write the equations for the following stresses i) Principal normal stresses in 2D ii) Maximum Shear Stress in 2D iii) Von-mises stress in 3D	*CO1*	*PO1*	**04**
	c)		List any five applications of FE method in engineering	*CO1*	*PO1*	**04**

			UNIT - II			
	3	a)	Write the shape functions for a linear bar element. Sketch their variation across the element.	*CO2*	*PO1*	**04**
		b)	What is global stiffness matrix? List its properties.	*CO2*	*PO1*	**04**
		c)	Determine the displacement at the mid-node and element stresses for the stepped bar shown in Figure-2. The load acting P=300 kN and the bar is subjected to a temperature increase of 40^0C. Also estimate the nodal reactions. $\alpha_1 = 23 \times 10^{-6}$ per ^{0}C $\quad \alpha_2 = 11.7 \times 10^{-6}$ per ^{0}C $E_1 = 70 \times 10^9 N/m^2 \quad E_2 = 200 \times 10^9 N/m^2$ $A_1 = 900\ mm^2 \quad A_2 = 1200\ mm^2$  Figure-2	*CO3*	*PO2*	**12**
			OR			
	4	a)	Describe penalty approach of handling boundary conditions. Indicate the solution equations.	*CO2*	*PO2*	**08**
		b)	For the stepped bar shown in Figure-3, estimate the nodal displacements, element strains and stresses. Also determine the reactions. Use penalty method for handling BCs.  Figure-3	*CO3*	*PO2*	**12**
			UNIT - III			
	5	a)	What are Hermite shape functions? Sketch their physical forms and give the equations.	*CO2*	*PO1*	**08**

		b)	For the two-member truss shown in Figure-4, estimate the nodal displacements at node 2. Also determine the element strains and stresses. Take E=200 GPa.  Figure-4	*CO3*	*PO2*	**12**
			OR			
	6	a)	For the beam shown in Figure-5, estimate the slope/rotation at the roller supports. Take E=200 GPa, I= $5x10^{-6}$ m^4.  Figure-5	*CO3*	*PO2*	**15**
		b)	Derive the stiffness matrix for a truss element from the stiffness matrix of bar element.	*CO2*	*PO2*	**05**
			UNIT - IV			
	7	a)	Derive the Jacobian matrix for a constant strain triangular element and hence obtain the strain-displacement matrix.	*CO2*	*PO2*	**12**
		b)	Differentiate the following element formulations: Sub-parametric, iso-parametric and super-parametric.	*CO2*	*PO1*	**06**
		c)	Write any two differences between 1-dimensional and 2-dimensional elements.	*CO2*	*PO1*	**02**
			OR			
	8	a)	Write the shape functions for the following elements: i) Quadrilateral element with four nodes. ii) Quadrilateral element with eight nodes	*CO2*	*PO1*	**08**
		b)	Write the Pascal triangle used for selection of polynomial terms.	*CO2*	*PO1*	**06**
		c)	What is FE solution convergence? How is it achieved?	*CO2*	*PO1*	**06**

			UNIT - V			
	9	a)	Derive the governing equation for 1-D heat condition.	*CO2*	*PO1*	**05**
		b)	For the composite wall of the furnace shown in Figure-6, convection heat transfer takes place at the inner side with heat transfer co-efficient of 25 W/m^{2}K. Determine the temperature distribution in the wall.  Figure-6	*CO3*	*PO2*	**15**
			OR			
	10	a)	Illustrate the variations of shape functions used in the formulation of one-dimensional thermal element.	*CO2*	*PO1*	**06**
		b)	Determine the temperature distribution in one dimensional fin shown in Figure-7. The uniform heat generation inside the wall is 500 W/m^3.  Figure-7	*CO3*	*PO2*	**14**

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