CBCS SCHEME

USN

BME701

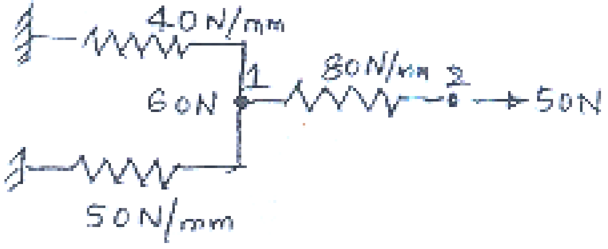
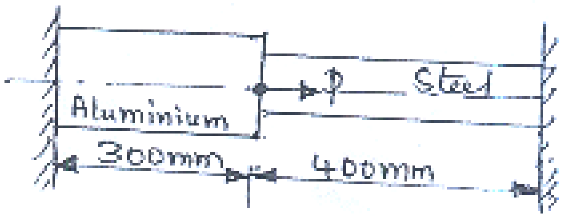
Seventh Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026

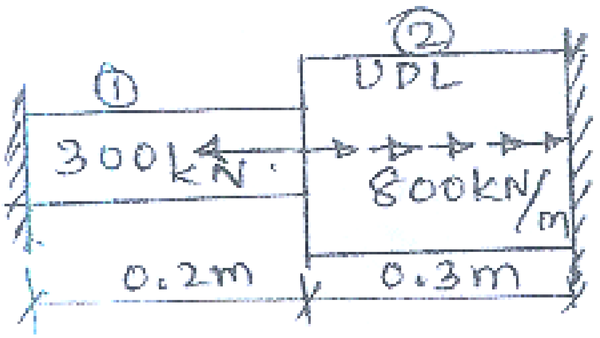
Finite Element Methods

Time: 3 hrs.

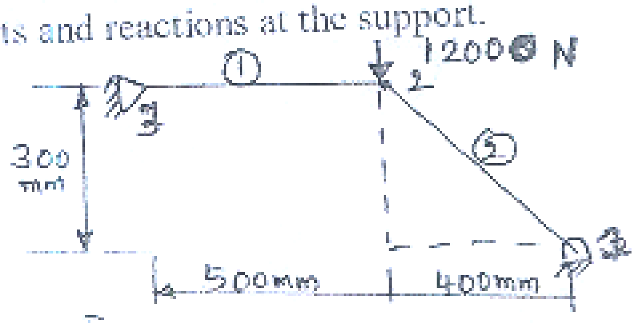
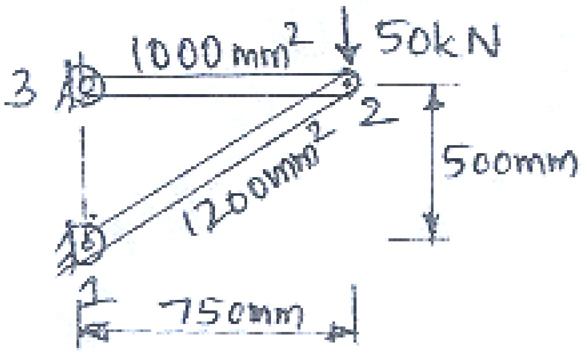
Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

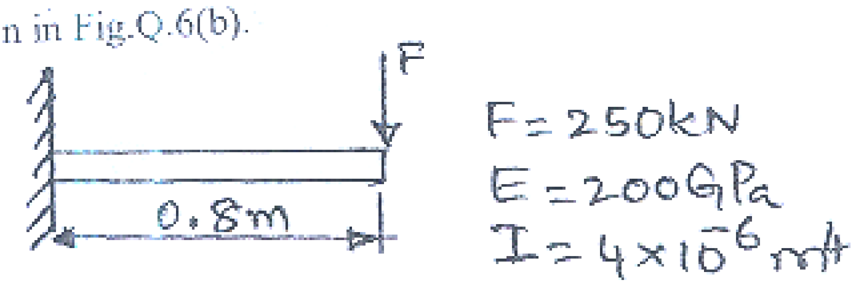
		Module – 1	M	L	C
Q.1	a.	Define FEM. Explain the basic steps in the finite element methods.	10	L2	CO1
	b.	Explain the plane stress and plane strain problems with examples, write the relation between stress and strain.	10	L2	CO1
		OR			
Q.2	a.	Using minimum potential energy determine the nodal displacement of a spring system shown in Fig.Q.2(a).  Fig.Q.2(a)	8	L3	CO1 CO2
	b.	A simply supported beam subjected to point load at the centre. Derive an equation for maximum deflection using trigonometric function by Rayleigh Ritz method.	12	L3	CO1 CO2
		Module – 2			
Q.3	a.	Derive shape functions (interpolation polynomial) for a 1-D bar element in natural coordinates.	8	L2	CO3
	b.	For the stepped bar shown in Fig.Q.3(b). Determine the nodal displacements, stress in each element and reaction at supports.  $E_{al} = 70 \times 10^9 N/m^2$ $E_s = 200 \times 10^9 N/m^2$ $A_{al} = 2400 mm^2$ $A_s = 600 mm^2$ $P = 200 kN$ Fig.Q.3(b)	12	L3	CO4 CO5
		OR			
Q.4	a.	Derive element stiffness matrix of a 1-D bar element. List the properties of stiffness matrix.	10	L2	CO3

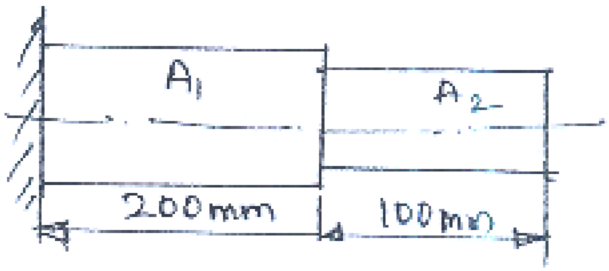
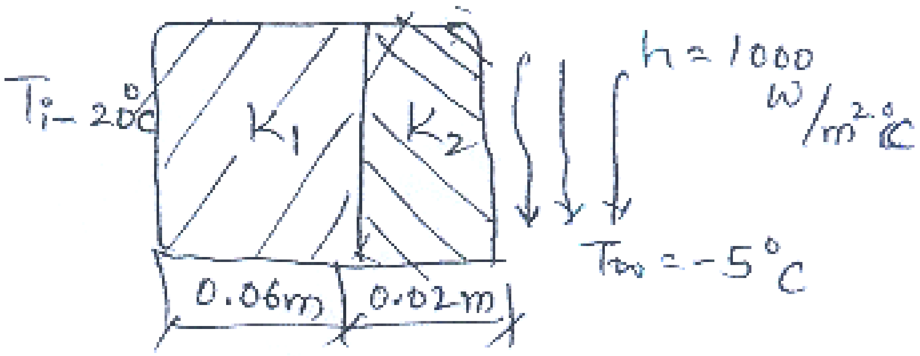
	b.	Find the nodal displacements, stress and reaction for the bar subjected to load as shown in Fig.Q.4(b). Take E_1 = 70 GPa, E_2 = 200 GPa.  $A_1 = 7.85 \times 10^{-8} m^2$ $A_2 = 3.14 \times 10^{-7} m^2$ Fig.Q.4(b)	10	L3	CO4 CO5

Module – 3

Q.5	a.	For the two-bar truss shown in Fig.Q.5(a) determine the displacements stress in each elements and reactions at the support.  $E = 2 \times 10^5 N/mm^2$ $A = 200 mm^2$ Fig.Q.5(a)	10	L3	CO4 CO5
	b.	For the two bar truss shown in Fig.Q.5(b). Determine the nodal displacements and stress in each member. Also find support reaction. Take E = 200GPa  Fig.Q.5(b)	10	L3	CO4 CO5

OR

Q.6	a.	Derive Hermite shape function for a beam element.	10	L2	CO3
	b.	Find the deflection at the free end and the support reaction of a cantilever beam shown in Fig.Q.6(b).  Fig.Q.6(b)	10	L3	CO4 CO5

		Module – 4			
Q.7	a.	Derive shape functions of Constant Strain Triangular (CST) element in natural coordinates.	10	L2	CO3
	b.	Obtain the shape functions of 4 noded rectangular (quadrilateral) element in Lagrangian-in natural coordinates.	10	L2	CO3
		OR			
Q.8	a.	Explain the concept of isoparametric, sub parametric, super parametric elements, with sketches.	10	L2	CO2
	b.	Obtain the shape functions of nine (9) noded rectangular element in Lagrangian.	10	L2	CO3
		Module – 5			
Q.9	a.	Derive an expression of element mass matrix for a bar element.	6	L2	CO3
	b.	For the stepped bar shown in Fig.Q.9(b) determine the eigen values and eigen vector. Take $A_1 = 400$ mm^2, $A_2 = 200$ mm^2, $\rho = 7850$ kg/m^3, E = 200 GPa.  Fig.Q.9(b)	14	L3	CO4 CO5
		OR			
Q.10	a.	Briefly describe rate equations and boundary conditions in heat transfer analysis.	6	L2	CO2
	b.	Determine the temperature distribution through composite wall shown in Fig.Q.10(b), when the convective heat loss occurs on the right surface. Take $K_1 = 6$ W/m°C, and $K_2 = 20$ W/m°C.  Fig.Q.10(b)	14	L3	CO4 CO5

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