U.S.N.										

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

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

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

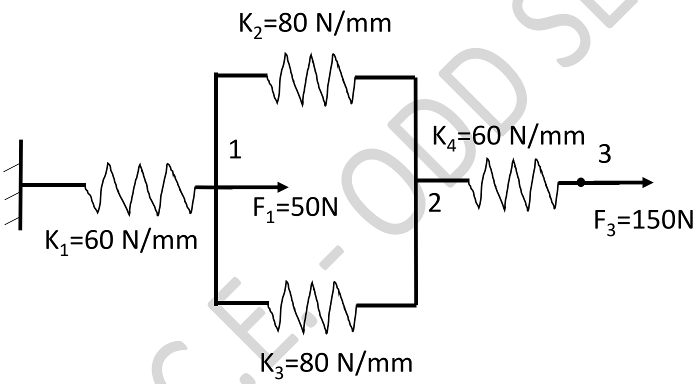
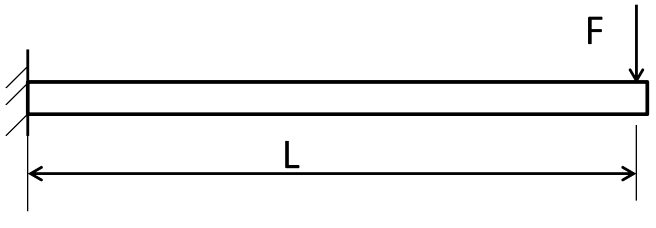
Branch: Aerospace Engineering **Duration: 3 hrs.**

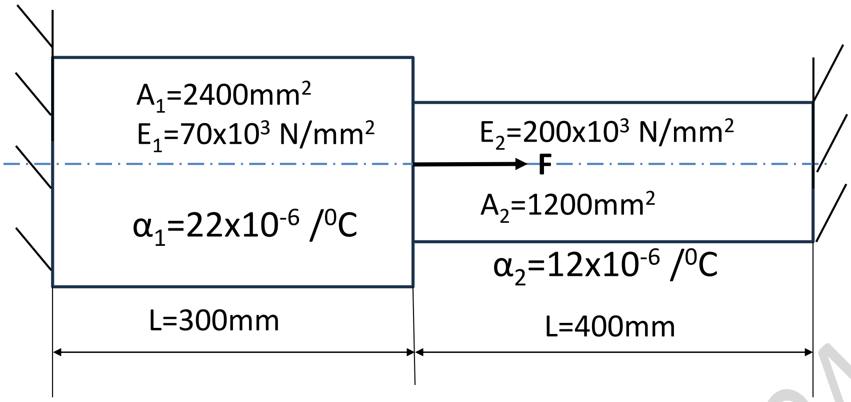
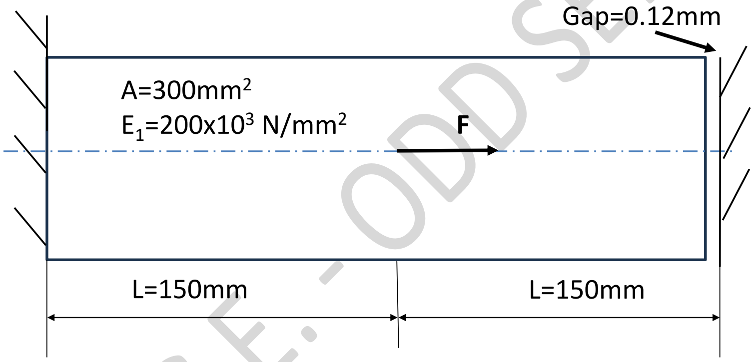
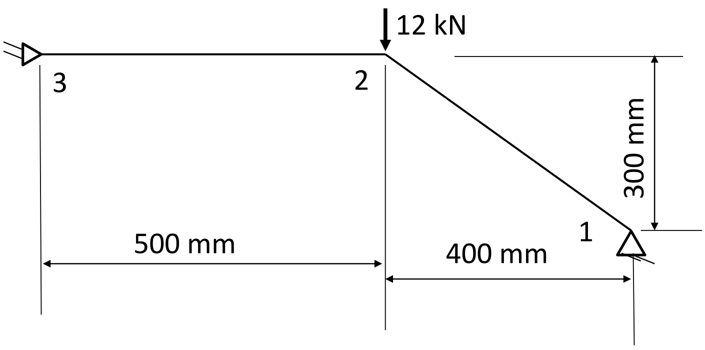
Course Code: 23AS5PEFEM / 22AS5PEFEM **Max Marks: 100**

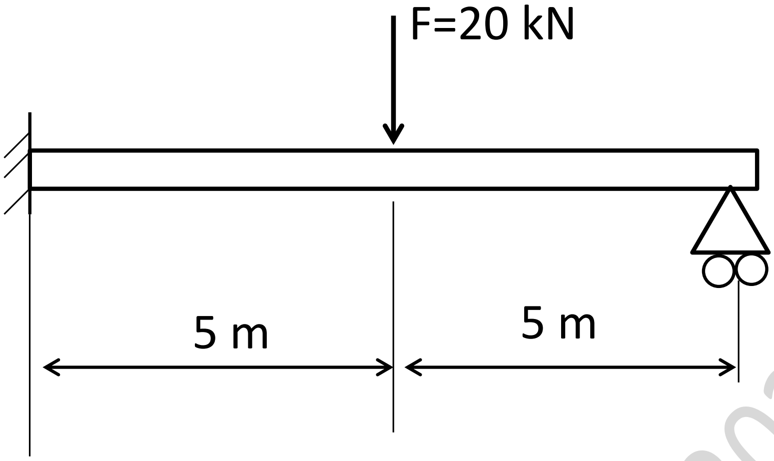
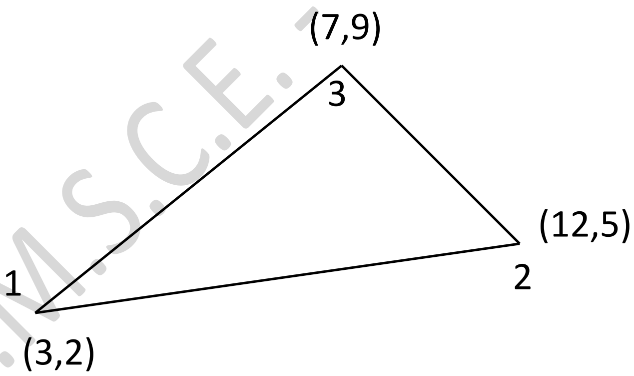
Course: Finite Element Method

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)	Illustrate and discuss the following 1) Normal stresses. 2) Torsional stress. 3) Direct shear stress	*CO1*	*PO1*	**06**
	b)	Derive equations of equilibrium for 2-dimensional stress field.	*CO1*	*PO1*	**06**
	c)	Obtain the displacement at nodes 1, 2 and 3 for the spring system shown in Fig. 1. The outward force acting at node 3 is 150 N.  Fig. 1	*CO1*	*PO2*	**08**
		OR			
2	a)	For the following beam shown in Fig. 2 obtain an expression for deflection at the point of application of load. Take the inertia of the beam as I and Young's modulus as E.  Fig. 2	*CO1*	*PO2*	**10**
	b)	Discuss the following stress-strain conditions with relevant sketch and equations. 1. Plane stress 2. Plane strain	*CO1*	*PO1*	**06**
	c)	List the applications of FEM in aerospace field.	*CO1*	*PO1*	**04**

			UNIT – II			
	3	a)	What is banded stiffness matrix for linear bar element? State the properties of the banded matrix.	*CO2*	*PO1*	**05**
		b)	For the stepped bar shown in Fig. 3, determine the nodal displacements, element strains and stresses. The temperature rise in the bar is 30^0C and the value of $F=400x10^3$ N.  Fig. 3	*CO2*	*PO2*	**15**
			OR			
	4	a)	A bar of uniform cross section shown in Fig. 4 is subjected a central loading of F=600 kN. Estimate the nodal displacements, element strains and stresses. Also determine the support reactions.  Fig. 4	*CO2*	*PO2*	**15**
		b)	Explain the penalty technique of FE solution.	*CO2*	*PO1*	**05**
			UNIT – III			
	5	a)	Differentiate between bar and truss elements.	*CO3*	*PO1*	**03**
		b)	For the following two element truss shown in Fig. 5, determine the nodal displacements and element stresses. Take $E=2x10^5$ N/mm^2, Area of both elements as 200 mm^2.  Fig. 5	*CO3*	*PO2*	**17**

			OR			
	6	a)	A beam fixed at one end and supported by roller at the other end carrying a point load as shown in Fig. 6. Taking Young's modulus as 200 GPa and area moment of inertia $I=24x10^{-6}\ m^4$, determine the deflection and slope and the mid-span of the beam.  Fig. 6	*CO3*	*PO2*	**12**
		b)	Derive the Hermite shape functions used for beam analysis. Also show their physical forms.	*CO3*	*PO1*	**08**
			UNIT - IV			
	7	a)	Derive the strain-displacement matrix for 2-dimensional CST element.	*CO4*	*PO1*	**12**
		b)	For the following triangular CST element shown in Fig. 7, determine the jacobian and the strain-displacement matrix.  Fig. 7	*CO4*	*PO1*	**08**
			OR			
	8	a)	What is solution convergence for FE analysis? Discuss different methods of achieving convergence.	*CO4*	*PO1*	**06**
		b)	With shape functions illustrate the higher order triangular and quadrilateral elements.	*CO4*	*PO1*	**06**
		c)	For the CST element with distributed pressure shown in Fig. 8, estimate the equivalent point loads at the nodes 1 and 2.			

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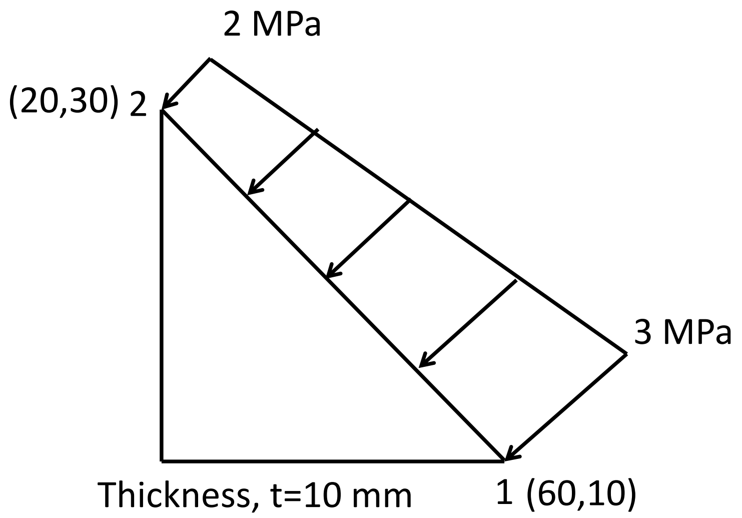
<tr><td></td><td></td><td></td><td>

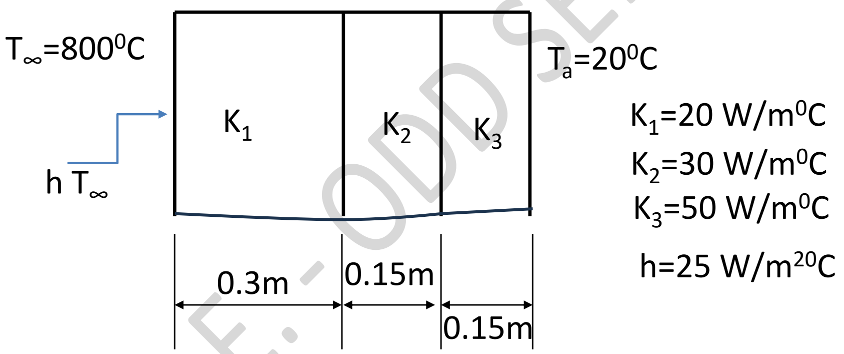
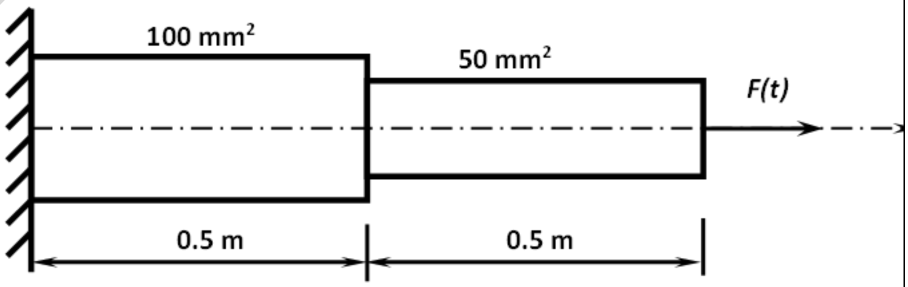
Fig. 8</td><td>CO4</td><td>PO2</td><td>08</td></tr>
<tr><td></td><td></td><td></td><td>UNIT – V</td><td></td><td></td><td></td></tr>
<tr><td></td><td>9</td><td>a)</td><td>Obtain 1-dimensional governing equation for heat conduction through the wall with heat generation.</td><td>CO4</td><td>PO1</td><td>06</td></tr>
<tr><td></td><td></td><td>b)</td><td>Solve for temperature distribution in the composite wall shown in Fig. 9.


Fig. 9</td><td>CO4</td><td>PO2</td><td>14</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>10</td><td>a)</td><td>Give the mass matrices for the bar and CST elements.</td><td>CO4</td><td>PO1</td><td>06</td></tr>
<tr><td></td><td></td><td>b)</td><td>Determine eigen values for the stepped bar shown in Fig. 10. Take E=200 GPa, density ρ= 7830 kg/m^3.

</td><td>CO4</td><td>PO2</td><td>14</td></tr>
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