GUJARAT TECHNOLOGICAL UNIVERSITY
BE- SEMESTER–VII (NEW) EXAMINATION – WINTER 2024

Subject Code:3171920   **Date:27-11-2024**
Subject Name: Finite Element Methods
Time:10:30 AM TO 01:00 PM   **Total Marks:70**
Instructions:
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	How do you mesh a given geometry?	**03**
	(b)	What are important material property to be considered in FEM?	**04**
	(c)	Enlist step by step procedure for Finite Element Analysis starting from a given differential equation.	**07**
Q.2	**(a)**	Draw different types of 1D, 2D and 3D elements.	**03**
	(b)	State various applications of FEM in different fields of engineering.	**04**
	(c)	Derive the shape function for beam element.	**07**

OR

	(c)	The structure in **Figure 1** is subjected to an increase in temperature $\Delta T = 100\ 0C$. Determine the displacements, stresses, and support reactions.	**07**
Q.3	**(a)**	Write Boundary conditions, force vector and stiffness matrix for Beams.	**03**
	(b)	What is Linear tringle element in FEA? Derive its stiffness matrix.	**04**
	(c)	Derive the relation between a bar element and a truss element.	**07**

OR

Q.3	**(a)**	Write down the shape functions for an axisymmetric element.	**03**
	(b)	Comment on the statement: "Finite Element Analysis plays a crucial rolein the new product development process."	**04**
	(c)	Write short note on FEM convergence requirements.	**07**
Q.4	**(a)**	Define shape function. What are the characteristics of shape function?	**03**
	(b)	Discuss the condition in plane stress and plain strain.	**04**
	(c)	Design a beam of ASTM A36 steel with allowable bending stress of 160 MPa to support the load shown in **Figure 2**. Assume a standard wide flange beam from standard material table or some other source can be used.	**07**

OR

Q.4	**(a)**	Classify full automatic techniques for mesh generation.	**03**
	(b)	Discuss the term CST & LST.	**04**
	(c)	Derive the stiffness matrix for one dimensional thermal element.	**07**
Q.5	**(a)**	Write the Lagrangian interpolation function.	**03**
	(b)	Discuss the role of interpolation function in FEA and derive shapefunctions for 1-D linear element.	**04**
	(c)	Illustrate the Plane Frames element with neat sketch indicating degree of freedoms. How it is differed from beam element. Write element stiffness matrix K, transformation matrix L and load vector F.	**07**

Q.5 **(a)** State the methods of engineering analysis. **03**

(b) In quadratic shape functions give the relationship between local and global coordinate system **04**

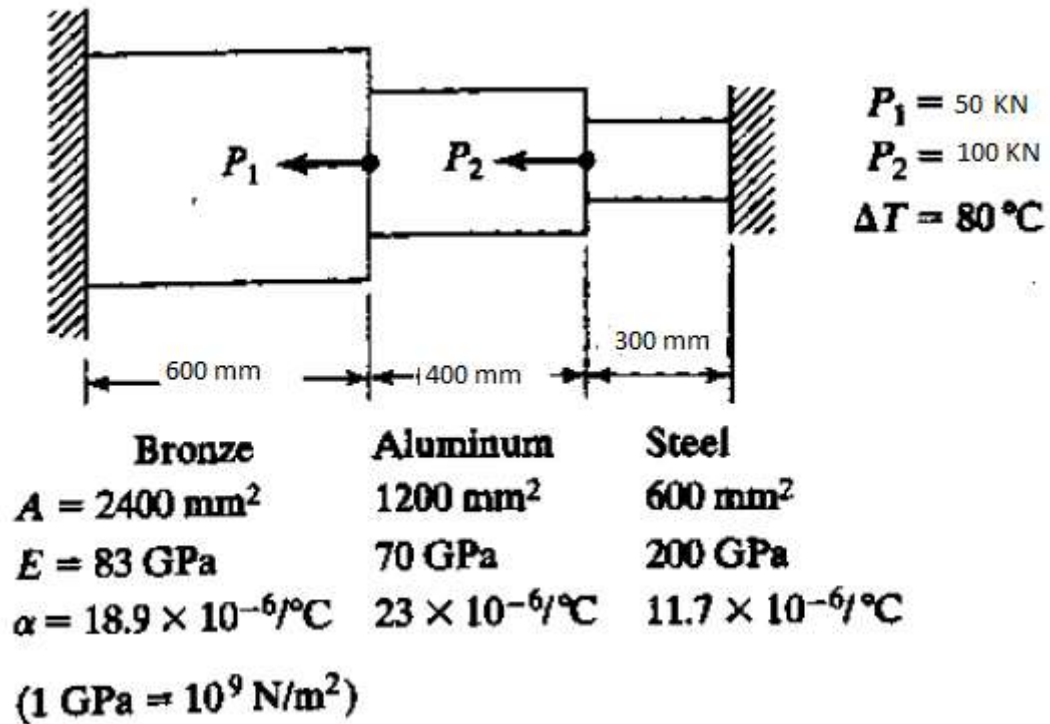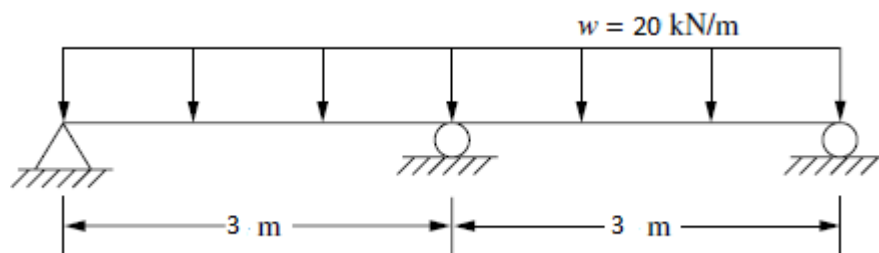**(c)** Write short notes on:Gaussian quadrature integration technique. **07**

$P_1 = 50$ KN
$P_2 = 100$ KN
$\Delta T = 80\,°C$

300 mm

600 mm   400 mm

Bronze	Aluminum	Steel
$A = 2400$ mm^2	1200 mm^2	600 mm^2
$E = 83$ GPa	70 GPa	200 GPa
$\alpha = 18.9 \times 10^{-6}/°C$	$23 \times 10^{-6}/°C$	$11.7 \times 10^{-6}/°C$

$(1 \text{ GPa} = 10^9 \text{ N/m}^2)$

Figure : 1

$w = 20$ kN/m

3 m   3 m

Figure : 2

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