Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2160609 **Date: 10/05/2017**

Subject Name: Computational Mechanics

Time: 10:30 AM to 01:30 PM **Total Marks: 70**

Instructions:

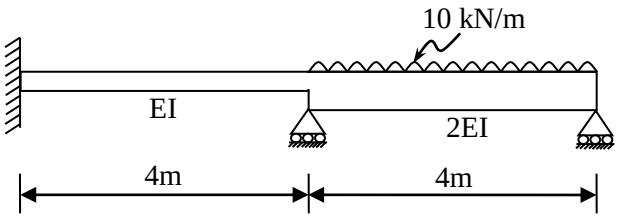
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Show neat sketches wherever necessary.**
4. **Figures to the right indicate full marks.**

Q.1		**Short Questions**	**14**
	1	What are the basic unknowns in stiffness matrix method?	
	2	Write truss member stiffness matrix in global directions.	
	3	Write beam member stiffness matrix.	
	4	Write rotation transformation matrix for truss member.	
	5	Give formulas of fixed end actions for abeam subjected to a linear temperature gradient such that the top of the beam has a temperature change ΔT_2, while the bottom has a change ΔT_1.	
	6	Give formulas of fixed end actions, if one of the end of a beam settles by δ.	
	7	Give the formula for the size of the joint stiffness matrix.	
	8	Give definition of S_{FF} and S_{RF}.	
	9	Why the stiffness matrix method is also called displacement method?	
	10	What is meant by finite element method?	
	11	Write basic steps in finite element method.	
	12	Define aspect ratio.	
	13	What are possible locations for nodes?	
	14	Give name of [D] and [B].	
Q.2	**(a)**	Derive member stiffness matrix $[S_M]$ for a beam.	**03**
	(b)	Determine rearranged joint stiffness matrix for the continuous beam shown in fig.1.	**04**
	(c)	Determine joint displacements and member end actions for the continuous beam shown in fig.1.	**07**
		OR	
	(c)	Determine combined joint load vector for the continuous beam shown in fig.2.	**07**
Q.3	**(a)**	Derive the equation $A_M = R^T A_S$ for rotation of axis in two dimensions.	**03**
	(b)	Determine S_{FF} matrix for the plane frame shown in fig.3.	**04**
	(c)	Determine joint displacements and member end actions for the plane frame shown in fig.3.	**07**
		OR	
Q.3	**(a)**	Explain in brief how to handle the effect of elastic support with neat sketch.	**03**
	(b)	Using concept of symmetry, determine S_{FF} matrix for the plane truss shown in fig.4.	**04**
	(c)	Using concept of symmetry, determine joint displacements and member forces for the plane truss shown in fig.4.	**07**
Q.4	**(a)**	Determine $[S_{MS}]_i$ for the grid shown in fig.5.	**03**
	(b)	Determine S_{FF} and S_{RF} matrix for the grid shown in fig.5.	**04**
	(c)	Determine joint displacements and support reactions for the grid shown in fig.5.	**07**
		OR	
Q.4	**(a)**	Derive shape function for 2-noded bar element.	**03**
	(b)	Explain procedure of discretization.	**04**
	(c)	Determine nodal displacements and element stresses for the bar shown in fig.6.	**07**

Q.5	**(a)**	Derive the element stiffness matrix coefficient k_{11} for a beam element of length l, if shape function $N_1=(2x^3-3x^2l+l^3)/l^3$.	**03**
	(b)	Explain in brief different types of non-linearity exist in solid mechanics problems?	**04**
	(c)	Find nodal displacements and nodal reactions for the beam shown in fig. 7.	**07**

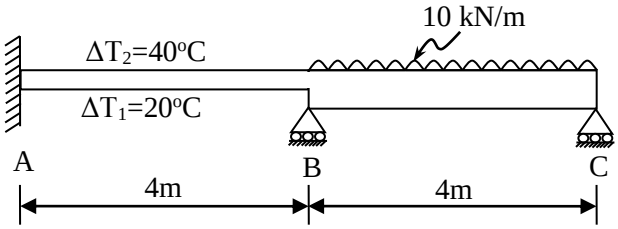
OR

Q.5	**(a)**	Derive strain displacement matrix [B] for constant strain triangle element.	**03**
	(b)	Find [B] and [D] for CST element shown in fig.8. Assume plane stress condition.	**04**
	(c)	Find nodal displacements and element stresses σ_x, σ_y and τ_{xy} for CST element shown in fig.8. Assume plane stress condition.	**07**



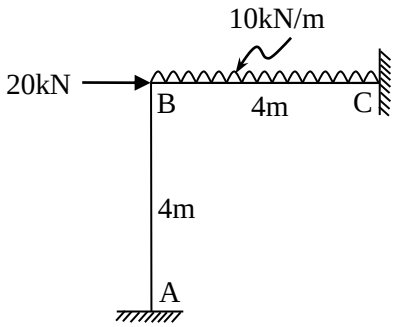
$EI = 10 \times 10^3$ kNm^2

Fig.1 [Q-2(b), Q-2(c)]



Size of beam AB = 0.200m × 0.300m.
Size of beam BC = 0.200m × 0.378m.
$E = 22.2222 \times 10^6$ kN/m^2
Coefficient of thermal expansion,
$\alpha = 1 \times 10^{-5}$ /°C.
Settlement of support B, δ_B = 10mm

Fig.2 [OR Q-2(c)]



For member AB & BC:
EI = constant
EA = constant
c/s area A=(133.333 I) m^2
where, I is in m^4

Fig.3 [Q-3(b), Q-3(c)]

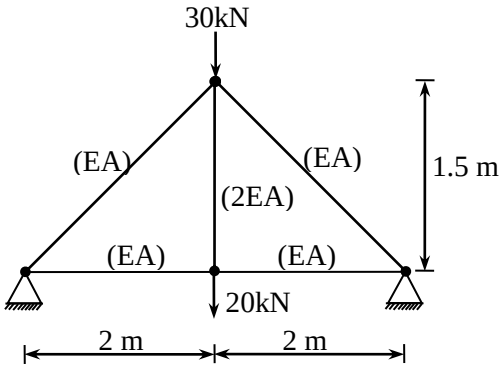
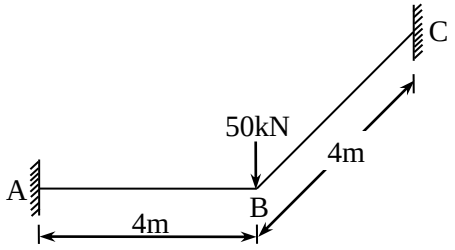
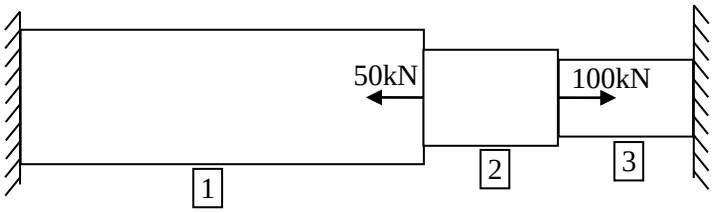


Fig. 4 [OR Q-3(b), OR Q-3(c)]



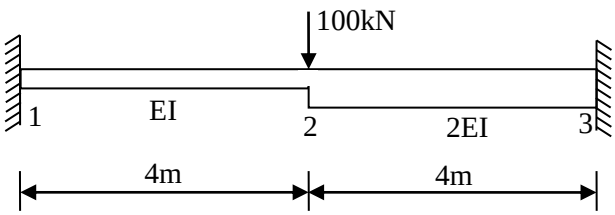
For member AB & BC:
GJ = constant
EI = constant
GJ = 0.8EI

Fig. 5 [Q-4(a), Q-4(b), Q-4(c)]



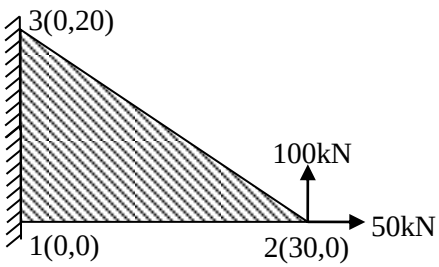
l_1 = 280 mm A_1 = 400 mm^2 E_1 = 70 kN/mm^2	l_2 = 100 mm A_2 = 200 mm^2 E_2 = 100 kN/mm^2	l_3 = 100 mm A_3 = 70 mm^2 E_3 = 200 kN/mm^2

Fig.6 [OR Q-4(c)]



EI = 10 × 10^3 kNm^2

Fig. 7 [Q-5(c)]



Coordinates are in mm
Thickness, t = 5 mm
E=200kN/mm^2
Poisson's ratio, ν = 0.25

Fig. 8 [OR Q-5(b), OR Q-5(c)]

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