Seat No.: ________ Enrolment No.________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI(NEW) – EXAMINATION – SUMMER 2019

Subject Code:2160609 Date:27/05/2019

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. **Figures to the right indicate full marks.**
4. **Draw neat sketch /diagram wherever necessary.**

Q.1	**(a)**	Derive member stiffness matrix of the beam member with usual notations.	**03**
	(b)	Explain symmetry and anti-symmetry with suitable examples.	**04**
	(c)	Analyse continuous beam ABC as shown in ***Figure-1*** using stiffness member approach and draw bending moment and shear force diagram. Assume EI to be constant for all members.	**07**
Q.2	**(a)**	Explain the concept of rotation of axes in 2D and derive relation $A_M = R_T A_S$, from first principles.	**03**
	(b)	Explain material and geometric nonlinearities using suitable examples.	**04**
	(c)	Determine the displacement and rotation under the force and moment located at the center of the beam in ***figure-2*** using stiffness member approach. Consider E = 210GPa and $I=4x10^{-4}$ m^4 .	**07**
		OR	
	(c)	Using stiffness member approach compute reactions continuous beam *ABCD as shown in* ***Figure-3*** when Support ***B*** sinks *down* by 0.005*m* and support ***C*** sinks down 0.01. Assume $E = 200$ *GPa* and $I = 4\times10^{-4}$ m^4.	**07**
Q.3	**(a)**	For the plane truss shown in ***figure-4***, determine the joint displacements and support reactions using stiffness member approach. Take modulus of elasticity E= 200 GPa and area of member AB=1500mm^2 and area of BC=CA=1500mm^2.	**07**
	(b)	Using member stiffness method obtain the member forces in the plane truss shown in ***figure-5*** and determine the support reactions. Take E = 200 GPa and A = 2000 mm^2.	**07**
		OR	
Q.3	**(c)**	Analyze the rigid frame shown in ***figure- 6*** by direct stiffness method. Assume E= 200*GPa*; $I_{ZZ} = 1.33x10^4$ m^4 and $A = 0.04m^2$. *EI* and axial rigidity *AE* are the same for both the members.	**07**
	(b)	A rigid frame is loaded as shown in the ***figure-6***, Compute the reactions and draw bending moment, shear force and axial force diagram if the support ***'C'*** settles by *10 mm* vertically downwards.	**07**
Q.4	**(a)**	Determine rearranged joint stiffness matrix for the grid shown in ***figure-7***. Both members have same torsional rigidity and flexural rigidity. Take GJ = 0.8EI. Consider P=10kN and L=4m.	**07**
	(b)	Determine the joint displacements of the truss shown in ***figure-8*** by member stiffness method. Assume that all members have the same axial rigidity AE=constant.	**07**
		OR	
Q.4	**(a)**	Enlist various steps of finite element method.	**03**
	(b)	Derive shape functions for 2-noded bar element.	**04**
	(c)	Derive the equation [k]{q}={f} using minimum potential energy approach.	**07**
Q.5	**(a)**	Determine the shape functions for a Constant Strain Triangular (CST) element in cartesian coordinate systems.	**03**

	(b)	Evaluate strain-displacement matrix of the CST element of ***figure-9***. The coordinates are given in units of millimeters. Let E = 210 GPa, Poisson's ratio = 0.25 and plate thickness = 10 mm.	**04**
	(c)	Three springs are joined together as shown in ***figure-10.*** Evaluate nodal displacements and forces in the springs.	**07**
		OR	
Q.5	**(a)**	Determine the element stiffness matrix for the element having coordinates as shown in ***figure-11*** in units of mm. Assume plane stress conditions. Consider $E=30\times10^{6}$ N/mm^2, Poisson's ratio = 0.25, and thickness t =1mm. The element nodal displacements have been determined to be u1 = 0.0, v1 = 0.0025 mm, u2 = 0.0012 mm., v2 = 0, u3 = 0 and v3 = 0.0025 mm..	**07**
	(b)	For the plane stress CST element shown in ***figure-11***, Determine the element stresses **σ_x, σ_y, τ_{xy}.**	**07**

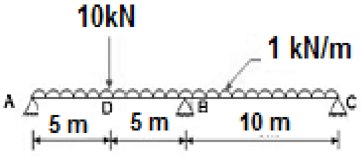

Figure-1

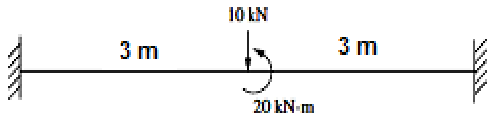

Figure-2

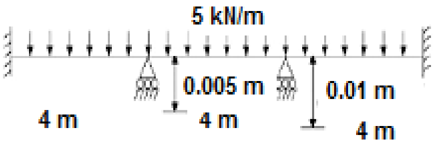

Figure-3

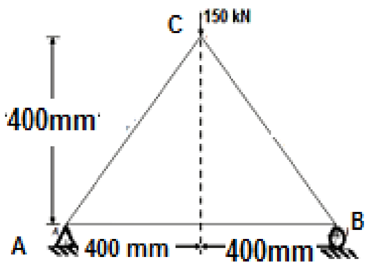

Figure-4

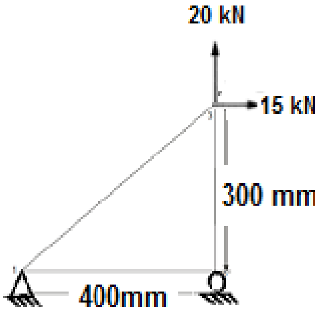

Figure-5

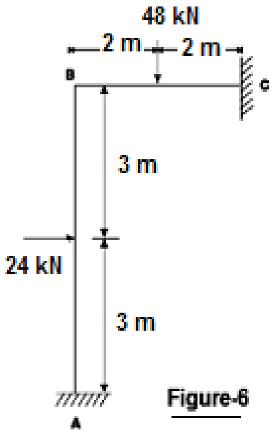

Figure-6

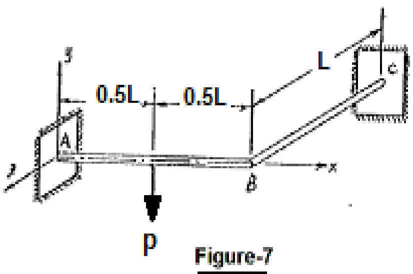

Figure-7

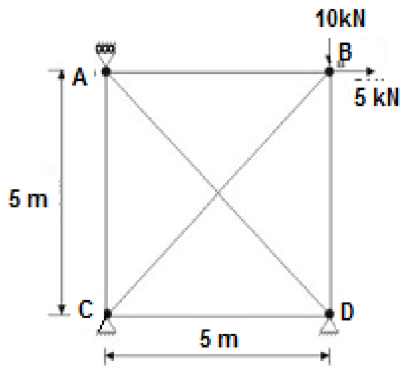

Figure-8

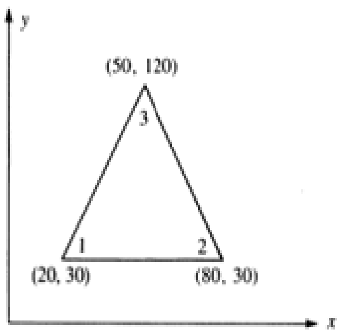

Figure-9

Figure-10

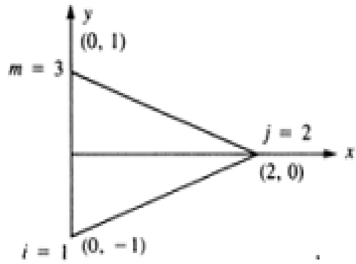

Figure-11

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