Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME SEMESTER II EXAMINATION – SUMMER 2017

Subject Code: 2724301 **Date:26/05/2017**

Subject Name: Finite Element Methods in Geotechnical Engineering

Time:02:30 PM to 05:00 PM **Total Marks: 70**

Instructions:

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

Q.1	**(a)**	Define: (i) discretization (ii) element aspect ratio (iii) isoparametric element	**07**
	(b)	Derive shape functions and element stiffness matrix for 2-noded bar element using either Cartesian coordinates or natural coordinates.	**07**
Q.2	**(a)**	Determine nodal displacement and element stresses for the element shown in fig. 1, using 2-noded elements.	**07**
	(b)	Explain plane stress and plane strain problems with neat sketches. Also, give their constitutive relationships.	**07**
		OR	
	(b)	Derive strain displacement matrix [B] for constant strain triangle using either Cartesian coordinates or natural coordinates.	**07**
Q.3	**(a)**	Evaluate the stiffness matrix for the CST element shown in fig.2. The coordinates are given in units of millimeters. Assume plane stress conditions. Take Modulus of elasticity E = 210 GPa, Poisson's ratio $\nu = 0.25$, and thickness t = 10 mm.	**07**
	(b)	For the CST element given in fig.2, the nodal displacements are given as $u_1 = 2$ mm, $v_1 = 1$ mm, $u_2 = 0.5$ mm, $v_2 = 0$ mm, $u_3 = 3$ mm, $v_3 = 1$ mm The coordinates are given in units of millimeters. Assume plane stress conditions. Determine the element stresses σ_x, σ_y, τ_{xy}. Take E = 210 GPa, $\nu = 0.25$, and thickness t = 10 mm.	**07**
		OR	
Q.3	**(a)**	Evaluate the stiffness matrix for the axisymmetric element shown in fig.3. The coordinates are given in units of millimeters. Take E = 210 GPa, and $\nu = 0.25$.	**07**
	(b)	For the axisymmetric element given in fig.3, the nodal displacements are given as $u_1 = 0.05$ mm, $v_1 = 0.03$ mm, $u_2 = 0.02$ mm, $v_2 = 0.02$ mm, $u_3 = 0$ mm, $v_3 = 0$ mm. The coordinates are given in units of millimeters. Determine the element stresses. Take E = 210 GPa, and $\nu = 0.25$.	**07**
Q.4	**(a)**	Derive shape functions for three noded bar element with natural coordinate −1, 0, and 1.	**07**
	(b)	Evaluate the strain displacement matrix [B] using 1×1 Gaussian points, for the quadrilateral element shown in fig.4. The coordinates are given in units of millimeters. Assume plane stress conditions. Take E = 210 GPa, $\nu = 0.25$, and thickness h = 10 mm.	**07**
		OR	
Q.4	**(a)**	For the two-noded one-dimensional isoparametric element shown in fig.5, determine intrinsic coordinate and shape functions at point P. If the displacements at nodes 1 and 2 are respectively, $u_1 = 0.1$mm and $u_2 = 0.2$mm, determine the value of the displacement at point P.	**07**

(b) For the four-noded linear plane element of thickness h shown in fig.6 with a uniform surface traction, determine the nodal load vector. **07**

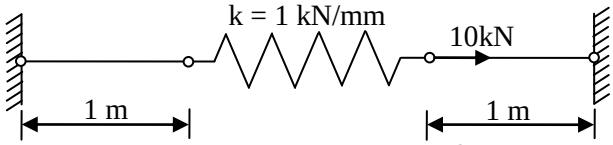
Q.5 **(a)** Evaluate the shape functions N_1, N_2, N_3 at the interior point P; and Jacobian [J] for the CST element shown in fig.7. **07**

(b) For the one-dimensional flow through the porous media shown in fig.8, determine the potentials at one-third and two-thirds of the length. Also determine the velocities in each element. Take c/s area A = 0.2 m^2. **07**

OR

Q.5 **(a)** Using Gaussian quadrature with two points, evaluate the integral $\int_{-1}^{1} \frac{\cos x}{1-x^2} dx$. The Gaussian points are ± 0.5774 and weights at the two points are equal to unity. **07**

(b) Enlist the software packages, based on FEM used for geotechnical problems. Explain the pre-processors for FEA modeling. **07**



E = 200GPa, A = 2000mm^2

Fig. 1 [Q-2(a)]

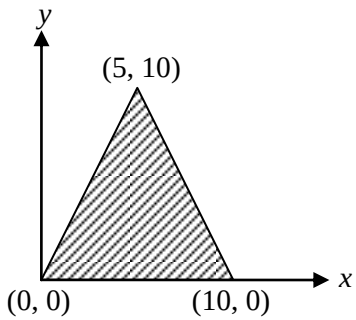


Fig. 2 [Q-3(a), Q-3(b)]

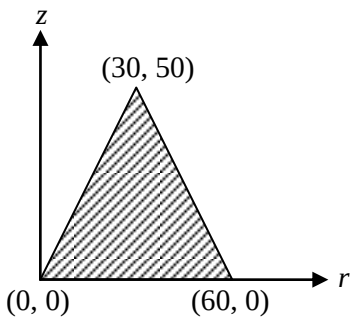


Fig. 3 [OR Q-3(a), OR Q-3(b)]

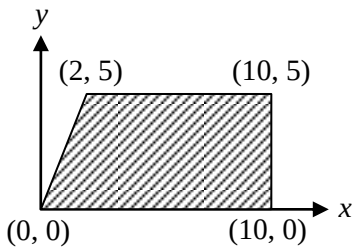


Fig. 4 [Q-4(b)]

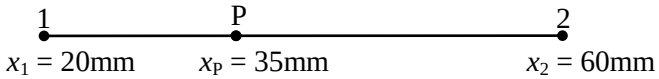


Fig. 5 [OR Q-4(a)]

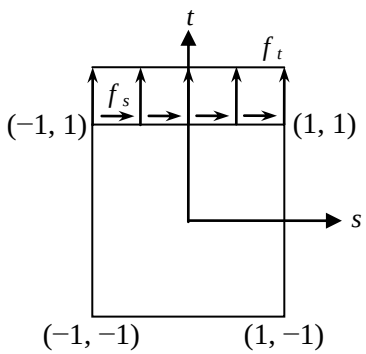


Fig. 6 [OR Q-4(b)]

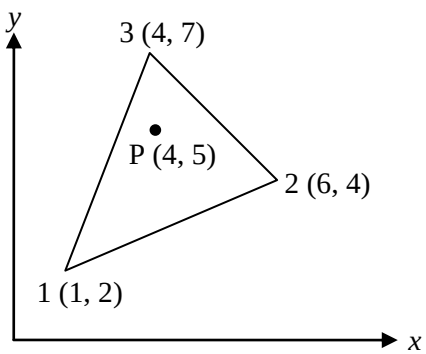


Fig. 7 [Q-5(a)]

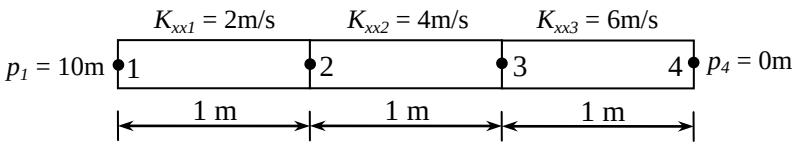


Fig. 8 [Q-5(b)]

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