Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering - SEMESTER - V EXAMINATION - WINTER 2025

Subject Code: 3150615 **Date: 25-11-2025**

Subject Name: Soil Mechanics

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.**

			Marks
Q.1	**(a)**	State the benefits of the triaxial test.	**03**
	(b)	Describe the different applications of geogrid, geomembrane, and geocell.	**04**
	(c)	Shear box test results for three clay specimens are provided as: Normal stress (kPa): 145, 241, 337; and Shear stress at failure (kPa): 103, 117, 132 Plot the failure envelope and analyze the soil's behavior. Discuss whether the soil exhibits purely cohesive, purely frictional, or c–φ characteristics.	**07**
Q.2	**(a)**	Summarize the separation and drainage functions of geosynthetics.	**03**
	(b)	A clay specimen has an unconfined compressive strength of 100 kPa. It is subjected to an unconsolidated–undrained (UU) triaxial test under a cell pressure of 100 kPa. Using the appropriate relation, calculate the axial stress at failure.	**04**
	(c)	A concentrated load of 50 kN acts on the surface of a homogeneous soil mass of large extent. Estimate the stress intensity at a depth of 5 m; (a) Directly under the load, and (b) At a horizontal distance of 5 m. Use Boussinesq's equation. Analyse and compare the results: Which location experiences higher stress? Why?	**07**
		OR	
	(c)	A long natural slope in a c-φ soil is inclined at 12° to the horizontal. The water table is at the surface and the seepage is parallel to the slope. If a plane slip has developed at a depth of 4 m, determine the factor of safety. Take C = 8 kN/m^2, φ = 22° and γ_{Sat} = 19 kN/m^3. Assess if stability is adequate and recommend justified improvements.	**07**
Q.3	**(a)**	Derive the principle of construction of Newmark's chart and explain its use.	**03**
	(b)	Using Boussinesq's expression, derive the expression for vertical stress at depth h under the centre of a circular area of radius a loaded uniformly with a load q at the surface of the mass of soil.	**04**
	(c)	A standard penetration test is conducted at a depth of 5 m in saturated fine sand having unit weight 20 kN/m^3. If observed N value is 25, then estimate the corrected N value.	**07**
		OR	
	(a)	Illustrate the vertical stress distribution on a horizontal plane at a given depth.	**03**

(b) Derive as per Boussinesq's theory, expressions for vertical stress at any point in a soil mass due to (i) line load on the surface, and (ii) strip load on the surface. **04**

(c) Evaluate the area ratio of a thin-walled tube sampler having an external diameter of 100 mm and wall thickness of 2 mm. **07**

Q.4 **(a)** Describe the standard penetration test. In what way is it useful in foundation design? **03**

(b) Describe with a neat sketch how will you carry out the wash boring method of soil exploration. **04**

(c) Compute net safe bearing capacity of a square footing 2.0 m × 2.0 m, located at a depth of 1.5 m below the ground level in a soil of unit weight 19 kN/m^3, $\varphi = 20^\circ$, Nc = 17.7, Nq = 7.4, Nγ = 5.0. Assume factor of safety equal to 3. The water table is very deep. If the water table touches the base of the footing, find the reduction in net safe bearing capacity. Use Terzaghi equation. Take unit weight of water 9.8 kN/m^3. **07**

OR

(a) Explain the terms 'inside clearance' and 'outside clearance' as applied to a sampler. **03**

(b) Describe geophysical exploration using electrical resistivity method. **04**

(c) Estimate net safe bearing capacity of a strip footing 1.5 m wide & 1.5 m depth, resting on a deep sand bed, consider, γ =18 kN/m^3, and bearing capacity factors N_C = 35.5, N_q = 23.2, N_γ = 22 corresponding to $\varphi = 38^\circ$and factor of safety = 3. Use Terzaghi equation. For a given footing that must support twice its net safe load, consider two designs:Option A: widen the footing to about B = 2.5 m at D_f = 1.5 m; Option B: keep B = 1.5 m but deepen to D_f = 3.75 m.Which option is more economical, and why? **07**

Q.5 **(a)** Distinguish between general shear failure and local shear failure. **03**

(b) Discuss the various factors that affect the bearing capacity of a shallow footing. **04**

(c) A square group of 16 piles was driven into soft clay extending to a large depth. The diameter and length of the piles were 50 cm and 9 m respectively. If the unconfined compression strength of the clay is 60 kN/m^2, and the pile spacing is 1 m centre to centre, estimate the ultimate capacity of the group. Assume adhesion factor of 0.6. Neglect bearing resistance. **07**

OR

(a) Explain the function of pile foundation and show how the bearing capacity of the foundation can be estimated for granular soils. **03**

(b) What is group effect and how will you estimate the capacity of a pile group in cohesive soil? **04**

(c) A 30 cm diameter pile is driven into a homogeneous clay (C = 45 kPa, N_c = 9). If the embedded length is 6 m, estimate the safe load (FS = 3). Assume the adhesion factor α = 0.7. Also analyze how changes in α, would affect the safe capacity. Also analyze how changes in α, would affect the safe capacity. **07**

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