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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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2024

Subject Code:3150615 Date:05-12-2024

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)**	Explain the terms 'inside clearance' and 'outside clearance' as applied to a sampler.	**03**
	(b)	Explain the principle of the direct shear test. What are the advantages of this test? What are its limitations?	**04**
	(c)	Use Boussinesq's theory and compute vertical stress values on a vertical plane located at radial distance of 1m away from a 200 kN point load acting at ground level. Compute the vertical stress values at 2 m, 3 m & 4 m depth.	**07**
Q.2	**(a)**	What are the criteria for deciding the depth of foundations?	**03**
	(b)	Explain Fellenius method for locating centre of slip circle.	**04**
	(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, $\phi = 22°$ and γ_{sat} =19 kN/m^3.	**07**

OR

	(c)	Determine the area ratio for the following soil samples and comment on the nature of samples obtained in each of the samples.	**07**

Soil sampler	Outer diameter (mm)	Inner diameter (mm)
(a) Core cutter	165	150
(b) Split barrel	51	35
(c) Seamless tube	51	48

Q.3	**(a)**	What are the assumptions made in Terzaghi's analysis of bearing capacity of a strip footing?	**03**
	(b)	Explain the concept of 'Pressure Bulb' in soils.	**04**
	(c)	A clay specimen has unconfined strength of 100 kPa & is subjected to UU Triaxial test under a cell pressure of 100 kPa. Find its axial stress at failure.	**07**

OR

Q.3	**(a)**	Explain the basic difference in the bearing capacity computation of shallow and deep foundations.	**03**
	(b)	Describe with a neat sketch how will you carry out the wash boring method of soil exploration.	**04**

	(c)	In an unconfined compression test, a cylindrical sample of clay 8 cm long and 4 cm in dia., fails under a load of 80 N. Evaluate shearing resistance if failure occurs at 10% strain.	**07**
Q.4	**(a)**	Explain unconfined compression test.	**03**
	(b)	Derive the principle of construction of Newmark's chart.	**04**
	(c)	Determine the safe bearing capacity of a strip footing 1.5 m wide & 1.5 m depth, resting on a deep sand bed, consider $\gamma = 18$ kN/m^3, and bearing capacity factors, $N_C = 35.5$, $N_q = 23.2$, $N_\gamma = 22$ corresponding to $\phi=38^\circ$ and factor of safety = 3. Use Terzaghi's equation.	**07**
		OR	
Q.4	**(a)**	Explain in brief about any two types of geosynthetic.	**03**
	(b)	Explain friction circle method of analysing the stability of slopes.	**04**
	(c)	Compute the 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,$\varphi = 20^\circ$, $N_c = 17.7$, $N_q = 7.4$, $N_\gamma = 5.0$. Take factor of safety = 3. The water table is very deep. If the water table touches the base of the footing, find the reduction in safe bearing capacity. Use Terzaghi's equation.	**07**
Q.5	**(a)**	Discuss the various factors that affect the bearing capacity of a shallow footing.	**03**
	(b)	What are the different applications of geotextile, and geocell.	**04**
	(c)	A 60 cm diameter pile is driven into a homogeneous clay having, C = 50 kPa, $\alpha = 0.7$. If the embedded length is 10 m, estimate the safe load. Take FOS = 2, and $N_C = 9$.	**07**
		OR	
Q.5	**(a)**	Explain about electrical resistivity method.	**03**
	(b)	Explain Engineering News formula.	**04**
	(c)	A concrete pile of 45 cm diameter was driven into sand of loose to medium density to a depth of 15 m. The following properties are known: Average unit weight of soil along the length of the pile, $\bar{\gamma} = 17.5$ kN/m^3, average $\varphi = 30°$, average $\overline{K_s} = 1.0$ and $\delta = 0.750$. Calculate the allowable load with FS = 2.5. Take $N_q = 16.5$.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2023

Subject Code:3150615 Date:13-12-2023

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)**	Explain Bore log in detail. Its prediction used in soil exploration.	**03**
	(b)	Define soil exploration and its objectives. Explain the stages of Site Investigations.	**04**
	(c)	Enlist the various methods of Exploration? Explain any one in detail with sketch.	**07**
Q.2	**(a)**	Difference between Flexible and Rigid pavements	**03**
	(b)	Differentiate between General shear failure and Local shear failure with neat sketch.	**04**
	(c)	A square pile group of 9 piles passes through a recently filled up material of 4 m depth. The diameter of the pile is 0.3 m and pile spacing is0.9m center to center. If the UCS of soil is 60 kN/m^2 and unit weight is 15 kN/m^3**.** Compute the negative skin friction.	**07**
		OR	
	(c)	Determine ultimate bearing capacity using Terzaghi's theory. A strip footing 1.5m wide resting on a saturated clay at a depth 2m below ground level. ($Ø = 0$, $\gamma_{sat.} = 20$ kN/m^3, C = 30 kN/m^2) The water table is also at a depth of 2m from the ground level. If the water table rise by 1m. Calculate the reduction in ultimate bearing capacity.	**07**
Q.3	**(a)**	Write the assumption and limitations of Terzaghi's Bearing capacity theory.	**03**
	(b)	Define Following: 1. Gross pressure intensity 2. Ultimate bearing capacity 3. Safe bearing Capacity 4. Allowable bearing Capacity	**04**
	(c)	Explain with neat sketch **SPT** in detail – its working principle, corrections applied	**07**
		OR	
Q.3	**(a)**	Name and explain the shear tests which may be performed based on the different drainage conditions.	**03**
	(b)	Explain importance of 'Unconfined Compression Test'& 'Laboratory Vane Shear Test'.	**04**
	(c)	Describe different types of Geosynthetics and its application with sketch in various domain of civil engineering.	**07**
Q.4	**(a)**	Enlist various classification of pile.	**03**

	(b)	Explain in detail "Under Reamed Pile Foundation".	**04**
	(c)	Write procedure for estimate the group capacity of piles in sand. Also explain negative skin friction and its effects on the pile?	**07**

OR

Q.4	**(a)**	Briefly explain with sketch Boussinesq's equation.	**03**
	(b)	Explain how the water table effects on bearing capacity.	**04**
	(c)	Explain Swedish circle method of stability analysis	**07**
Q.5	**(a)**	Discuss various types of slope failures	**03**
	(b)	Differentiate the Infinite and finite slope.	**04**
	(c)	Critically explain factors affecting bearing capacity in detail with sketch.	**07**

OR

Q.5	**(a)**	Elaborate the conditions where a pile foundation is more suitable than a shallow foundation.	**03**
	(b)	Explain the concept of Pressure Bulb with neat sketches.	**04**
	(c)	Explain in detail Plate load test with neat sketch. Its importance and out puts from this test.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2022

Subject Code:3150615 Date:13-01-2023

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.**

Q.1 **(a)** Answer the following. (Write full sentence) **03**

1 Pore pressure coefficient B is a function of

(a) Over consolidation ratio (b) Degree of saturation

(c) Under consolidation ratio (d) None of the above

2 Undisturbed samples are obtained by

(a) Direct excavation (b) Augurs

(c) Thick wall sampler (d)Thin wall sampler

3 The foundation whose length is considerably greater than its width, is called

(a) Strip footing (b) Strap footing

(c) Isolated footing (d) Combined footing

(b) Give the comparison of Boussinesq and Westergaard theory for stress distribution analysis. **04**

(c) Determine the allowable gross load and net allowable load that can be carried out by a square footing of size 2 m x 2 m , placed at a depth of 1.0 m below ground level. The water table is at a great depth. Foundation soil has the properties: γ_d =18 kN/m^3, C = 15 kN/m^2. Use Terzaghi's theory. For ϕ = 25°, N_c' = 14.8, N_q' = 5.6, N_γ' = 3.2 Assume F.S. = 3. **07**

Q.2 **(a)** What are the basic requirement of a good pavement? **03**

(b) What is a stress path? Draw stress path for foundation loading and unloading condition. **04**

(c) Explain Swedish circle method of slice for stability of slope. **07**

OR

(c) Derive the expression for the factor of safety of an infinite slope in a cohesionless soil. **07**

Q.3 **(a)** Answer the following. (Write full sentence) **03**

1 Newmark's influence chart can be used for the determination vertical stress under

(a) Circular load area only (b) Rectangular load area only

(c) Strip load only (d) Any shape of the loaded area

2 In-situ Vane shear test is used to measure the shear strength of

(a) Soft clayey soil (b) Sandy soil

(c) Gravelly soil (d) All types of soil

3 The ultimate bearing capacity is well defined in

(a) Local shear failure (b) Punching shear failure

(c) General shear failure (d) Settlement failure

(b) A vertical cut is made in a clay deposits. The soil properties are C= 30 kN/m^2, Ø = 0°, γ = 16 kN/m^3. Find he maximum height of the cut which can be temporarily supported. Take S_n = 0.261. **04**

(c) Explain the corrections involved in Standard Penetration Test. **07**

OR

Q.3 **(a)** Answer the following. (Write full sentence) **03**

1 Elastic shock waves have different velocities in different material is the principle involved in

(a) Electrical resistivity method (b) Seismic refraction method

(c) Both (a) and (b) (d) Pressure meter method

2 The function which is not served by geotextile material is

(a) Filtration (b) Drainage

(c) Reinforcement (d) Dynamic loading

3 If the angle of friction is greater than angle of slope, the slope is always stable. (True/False)

(b) A long strip footing of width 2 m carries a load of 400 kN/m. Calculate the maximum stress at a depth of 5 m below the centre line of footing. **04**

(c) Discuss step by step procedure to perform Tri axial shear test in the laboratory. **07**

Q.4 **(a)** " The settlement of a group of pile is more than the settlement of a single pile." Comment on the statement. **03**

(b) What are the different methods to improve slope stability? **04**

(c) An unconfined compression test was conducted on an undisturbed clay sample. The sample had a diameter of 37.5 mm and 80 mm long. The load at failure measured by proving ring was 28 kN and the axial deformation of the sample at failure was 13 mm. Determine the unconfined compressive strength and un drained shear strength of the clay. **07**

OR

Q.4 **(a)** Answer the following. (Write full sentence) **03**

1 The piles which are used to protect water front structures are called

(a) Load bearing piles (b) Sheet piles

(c) Tension piles (d) Fender piles

2 Negative skin friction is predominant in

(a) Friction piles in sand (b) Friction piles in soft clay

(c) Piles resting on hard soil (d) Bearing pile

3 The group efficiency of driven piles in sand at a close spacing may be

(a) Equal to 100% (b) Greater than 100%

(c) Well below 100% (d) Can not be said

(b) Explain the effect of water table on bearing capacity of soil. **04**

(c) Discuss various dynamic pile formulae with meaning of each term in it. What are their limitations? **07**

Q.5 **(a)** Explain the Feld rule to determine efficiency of a pile group. **03**

(b) Write the functions of geosynthetic materials and explain any one of them. **04**

(c) A pile group consists of 9 piles of 30 cm diameter and 10 m length driven in clay. The soil properties are C_u = 100 kN/m^2, γ = 20 kN/m^3. Calculate the safe load for the pile group. Take factor of safety = 3 and α = 0.6. **07**

OR

Q.5 **(a)** Name important hydraulic and mechanical properties of geosynthetic materials. **03**

(b) Draw an under reamed pile with detailed configuration. **04**

(c) Explain pile load test for determining load carrying capacity of a pile with neat and clean sketch. **07**

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