Last Date for submission of Assignments

SUBJECT: Geotechnical Engineering

SUBJECT CODE: 3130606

SEMESTER: 3RD Civil Engineering

Assignment Number	Assignment Name	Last Date of Submission
1	**Index Properties of Soil**	13/10/2022
2	**Permeability and Shear Strength of Soil**	20/11/2022
3	**Compaction and Consolidation of Soil**	24/11/2022
4	**Stress Distribution, Earth Pressure & Stability of Slopes**	08/12/2022
5	**Introduction to Foundations and Bearing Capacity**	22/12/2022

GUJARAT TECHNOLOGICAL UNIVERSITY

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ASSIGNMENT 1: INDEX PROPERTIES OF SOIL

Sr. No.	Questions
1	Explain soil formation in Geological cycle.
2	What is weathering? Enumerate the type of weathering. Distinguish between physical and
3	Write note on transportation of soil.
4	Explain the types of soil in detail.
5	Write note on soil types in Gujarat.
6	Explain three phase diagrams of soil in detail.
7	Define following terms with respective equations. a) Water content b) Bulk unit weight c) Dry unit weight d) Saturated unit weight e) Submerged unit weight f) Unit weight of solids g) Specific Gravity h) Absolute specific gravity i) Void ratio j) Porosity k) Degree of saturation l) Air content m) Percentage air voids n) Relative density and give the range of relative density for different types of soil
8	Derive the following relationship. a) $e = \frac{n}{1-n}$ b) $n = \frac{e}{1+e}$ c) $\gamma_b = \frac{(G+e.\,S_r)\gamma_w}{1+e}$ d) $e = \frac{w.\,G}{S_r}$ e) $\gamma_d = \frac{\gamma_b}{1+w}$

9	Enlist the various methods of water content determination of soil and explain oven drying method in detail.
10	Explain specific gravity determination test.
11	Explain core cutter and sand replacement method.
12	A sample of silty clay has a volume of 14.88 cm3, total weight of 28.81 gm, dry weight is 24.83 gm and specific gravity is 2.7. Determine the void ratio and degree of saturation. ***Answer**: Void ratio= 0.618 and Degree of saturation= 70%*
13	A soil sample in its natural state has a weight of 2.29 kg and volume of 1.15x10-3 m3, under an over dried state, the dry weight of the sample is 2.035 kg. The specific gravity of the soil is 2.68. Determine the total unit weight, water content, void ratio, porosity, degree of saturation and air content. ***Answer**: Total unit weight= 19.5 kN/m^3, Water content= 12.5%, Void ratio= 0.51, porosity= 34%, Degree of saturation= 65.6%, Air Content= 12%*
14	A Soil sample has a porosity of 40 percent. The specific gravity of solids is 2.7. Calculate (a) Void ratio (b) Dry density (c) Unit weight if the soil is 50% saturated (d) Unit weight of soil if the soil is completely saturated. ***Answer**: (a) Void ratio = 0.67 (b) Dry density= 15.86 kN/m^3 (c) unit weight at 50% saturation= 17.83 kN/m^3 (d) unit weight for fully saturated soil= 19.79 kN/m^3*
15	In a field density test, the volume and wet weight of soil obtained are 785 cc and 15.8 N respectively. If the water content is found to be 36%, determine the wet and dry unit weight of the soil. If the specific gravity of the soil grains is 2.6, compute the void ratio. ***Answer**: Wet unit weight= 20.11 kN/m^3 , Dry unit weight= 14.78 kN/m^3 and void ratio= 0.726*
16	Give difference between fine grained and coarse-grained soil.
17	Write short note on Particle size distribution curve.
18	Write short note on stokes law and also give assumptions and its limitations.
19	Draw Particle size distribution curves for different types of soils and also give its significance.
20	Describe the following terms with their probable range: Co-efficient of uniformity and Co- efficient of curvature.
21	What are different types of soil structure which can occurs in nature? Describe in brief. Write short note on different shapes of the particles.
22	Write short note on diffuse double layer.
23	What is the purpose of Soil Classification?

24 Enlist various soil classification systems.

25 Write short note on followings

Particle size classification	Textural classification
Unified soil classification	IS Soil Classification

26 Draw and explain IS Plasticity chart.

27 Write short note on field identification of fine-grained soil.

28 Sieve analysis was conducted on a sample of coarse-grained soil and the following results obtained:

Gravel= 12 %,
Sand= 88 %
D_{10}= 0.16 mm
D_{30}= 0.64 mm
D_{60}= 1.22 mm
Classify the soil as per Unified soil Classification system.

29 Define the following terms

Liquid limit	Plastic limit
Shrinkage limit	Plasticity index
Shrinkage index	Liquidity index
Flow index	Toughness index
Activity of Soil	Sensitivity of Soil
Thixotropy of Soil	

30 The liquid limit and plastic limit of a soil sample are 65 % and 29 % respectively. The percentage of soil fraction with grain size finer than 0.002 mm is24. Calculate the activity ratio of the soil sample.

31 The liquid limit of a soil is 62 % and its plastic limit is 34 %. Classify the soil as per IS Classification.

32 A test for the determination for the liquid limit gave the following observations. Plot the flow curve and determine liquid limit and flow index.

No. of Blows (N)	38	27	20	13
Water Content %	47	49	51	53

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ASSIGNMENT 2: PERMEABILITY AND SHEAR STRENGTH OF SOIL

1. Write short note on soil water present in soil mass.
2. Define total stress, neutral stress and effective stress. What is the importance of the effective stress?
3. A deposit of sand 10m thick overlies a bed of soft clay. The ground water table is 3m below the ground surface. If the sand above the ground water table has a degree of saturation 40%, plot the diagram showing the variation of the total stress, neutral stress and effective stress. Take G= 2.65 and e=0.70.
4. Define Following terms

a) Permeability	b) Total Head
c) Hydraulic Head	d) Hydraulic Gradient
e) Percolation (Seepage)	f) Discharge velocity
g) Seepage Velocity	h) Piping
i) Boiling or Quick Sand	j) Coefficient of permeability
k) Aquifer	l) Aquiclude
m) Aquitard	n) Aquifuge
o) Unconfined aquifer	p) Confined aquifer

5. What is flow net and characteristics of flow net? Also explain the application of flow net?
6. A horizontal stratified deposit of three layer of soil having of 3 m, 2 m and 4 m respectively. The coefficient of permeability of corresponding individual layer is $3x10^{-3}$ cm/s, $6.5x10^{-2}$ cm/s and $7x10^{-4}$ cm/s. Calculate the effective equivalent coefficient of permeability of the deposit in (a) Horizontal direction (b) Vertical direction
7. What is the importance of permeability in the field? Enlist the laboratory and field test of permeability and explain Constant head permeability test.
8. How will you get shear strength parameters of soil? Describe direct box shear test. What are its limitations?

9. Explain Mohr-coulomb's Strength theory. Sketch typical Mohr-coulomb's strength envelop for C- Soil ∅-Soil and C-∅ Soil.

10. Briefly explain the shear tests which may be performed based on the different drainage conditions? With its field applications.

11. What are the advantages and disadvantages of Triaxial Shear Test.?

12. Describe unconfined compression test. What are its advantages over Triaxial test?

13. Describe laboratory vane shear test with neat sketch.

14. In an unconfined compression test, a sample of clay 8 cm long and 4 cm in diameter fail under a load of 120 N at 10% strain. Find the shearing resistance taking into account the effect of change in cross section of sample.

15. Determine the shearing strength parameters from the Direct Shear Test results given below:

Sr. No.	Normal Stress (kN/m^2)	Shear Stress (kN/m^2)
1.	150	110
2.	200	120

What would be the deviator stress if triaxial test is carried out on same soil with cell pressure of 150 kN/m^2?

16. From the Undrained Triaxial test results given below, determine the shear strength parameters c & ϕ.

Sr. No.	Cell Pressure (kPa)	Deviator Stress (kPa)
1.	200	690
2.	400	840
3.	600	990

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ASSIGNMENT 3: COMPACTION AND CONSOLIDATION OF SOIL

1. Explain factors affecting compaction of soil.
2. Write Difference between heavy compaction test and light compaction test.
3. Discuss the effects of compaction on various soil properties
4. The maximum dry density and optimum moisture content of soil from standard proctor test are 1.9 kN/m3 and 14% respectively. Compute water content necessary to completely saturate the sample at its maximum dry density. Assuming no change in volume G = 2.7
5. The following data were recorded while performing the compaction test: -

Water content (%)	7.71	11.5	14.6	17.50	19.50	21.25
Bulk density (kN/m3)	17.55	19.50	21.0	20.55	20.30	19.80

Plot the MDD-OMC curve and obtain the optimum water content and maximum dry density. Also plot zero air voids curve. Take G = 2.66

6. The following are the observation of a compaction test.

Water content (w %)	7.7	11.5	14.6	17.5	19.5	21.2
Wt. of wet soil W (N)	16.67	18.54	19.92	19.52	19.23	18.83

the volume of compaction mould is 950 cc. Assuming G = 2.65. Draw the compaction curve. Report maximum dry unit weight and optimum moisture content (OMC). Draw 100% saturation line (zero air void line). What is the degree of saturation at OMC?

7. Explain theory of spring analogy for primary consolidation.
8. Differentiate between normally consolidated and over-consolidated soils.
9. Enlist various causes for Pre-consolidation of soils. Discuss the Casagrande's method to determine the pre-consolidation pressure from consolidation test data.
10. Explain 'Square root of time fitting method' and 'logarithm of time fitting method' for determination of coefficient of consolidation.

11. During consolidation test, the void ratio decreases from 0.80 to 0.50 under the stress increment of 2.0 kg/cm^2 to 4.0 kg/cm^2. Compute coefficient of compressibility & coefficient of volume compressibility.

12. Define the following terms:

- Primary Consolidation
- Secondary Consolidation
- Coefficient of Compressibility,
- Coefficient of Volume Compressibility,
- Compression Index
- Coefficient of Consolidation
- Degree of Consolidation
- Cohesion (C)
- Angle of Internal Friction (∅)

13. Explain 'Square root of time fitting method' and 'logarithm of time fitting method' for determination of coefficient of consolidation.

14. During consolidation test, the void ratio decreases from 0.80 to 0.50 under the stress increment of 2.0 kg/cm^2 to 4.0 kg/cm^2. Compute coefficient of compressibility & coefficient of volume compressibility.

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ASSIGNMENT 4: STRESS DISTRIBUTION, EARTH PRESSURE & STABILITY OF SLOPES

1.	Write short note on "New mark's influence chart".
2.	Derive the "Boussinesq's equation of vertical stress and tangential stress subjected to concentrated force.
3.	Illustrate the procedure for plotting an isobar of intensity 0.1 Q. Also draw Isobar diagram.
4.	What is pressure bulb? Explain its use.
5.	A concentrated load of 50 kN acts on the surface of a homogeneous soil mass of large extent. Find the stress intensity at a depth of 5m and Directly under the load, and at a horizontal distance of 5m. Use Boussinesq's equation.
6.	A rectangular foundation 4m x 3m transmits a uniformly pressure of 450 kN/m^2 to the under-laying soil. Determine the Vertical stress at a point 3 m vertically below a point lying within the loaded area 1.5 m away from the short edge and 1 m away from the long edge. Use Boussinesq's theory.
7.	What are the graphical methods available for the determination of lateral earth pressure? Explain any one in detail.
8.	Elaborates the shortcomings of Rankine's active earth pressure theory and Coulomb's active earth pressure theory.
9.	Write a short note on "Active Earth Pressure for Cohesive Soils".
10.	What are different types of Earth Pressures? Give examples.
11.	Define Earth pressure at Rest. Show the earth pressure distribution on a retaining wall, assuming that the soil fill is dry.
12.	A retaining wall of 4 m high has a smooth vertical back. The backfill has a level with the top of the wall. There is a uniformly distributed surcharge load of 36 kN/m^2, intensity over backfill. The unit weight of the backfill is 18 kN/m^3, its angle of shearing resistance is 30^0 and cohesion is zero. Determine the magnitude and point of application of active earth pressure per meter length of the soil.

13.	Determine the active earth pressure on the retaining wall of 5 m high for following data. 1. Top 2.5 m, soil Ø = 35^0 and γ = 17 kN/m^3 2. Bottom 2.5 m, soil Ø = 38^0 and γ = 18 kN/m^3 Water level is at 2.5 m below ground surface. Adopt γ_w = 10 kN/m^3.
14.	A retaining wall, 5 m. high, with vertical back, retains soil fill, the upper face of fill is horizontal. The back face of the wall is smooth. Determine the Rankine active earth pressure on the wall, (a) before the formation of crack and (b) after the formation of crack. Take C = 5 kN/m^2, γ = 17.5 kN/m^3, and Angle of internal friction = 30°.
15.	A retaining wall, 6 m. high, retains dry sand with an angle of friction of 30°, and unit weight of 16.2 kN/m3. Determine the earth pressure at rest. If the water table rises to the top of the wall, determine the increase in the thrust on the wall. Assume the submerged unit weight of sand as 10 kN/m3.
16.	What are different factors of safety used in the stability of slopes? Discuss briefly.
17.	Discuss briefly, different types of slope failures.
18.	How a slope is analyzed using a Swedish circle method (method of slices)? Discuss the method and derive an expression for the factor of safety.
19.	Briefly describe the method of slices for finite slope stability analysis for C-Φ soil.
20.	A long natural slope in C-Φ soil is inclined at 12° to the horizontal. The water table is at the surface and seepage is parallel to the slope. If a plane slip has developed at a depth of 4.0 m, determine the factor of safety. Take C = 10 kPa, Φ = 20°& γ_{sat} = 20 kN/m^3.
21.	Determine the factor of safety against sliding for a slip surface passing through the toe of a finite slope of height of 11m and slope angle of 1V:1.5H has c= 15 kPa, Φ = 32° and γ= 20 kN/m^3. The radius & the central angle of the slip circle are 17.4 m & 870 respectively. Take ΣN = 1902.74 kN and ΣT = 941.15 kN. Use Swedish slip circle method.

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ASSIGNMENT 5: INTRODUCTION TO FOUNDATIONS AND BEARING CAPACITY

1. Define the followings terms.
   - **a)** Foundation
   - **b)** Footing
   - **c)** Ultimate Bearing Capacity
   - **d)** Net Ultimate Bearing Capacity
   - **e)** Net Safe Bearing Capacity
   - **f)** Gross Safe Bearing Capacity
   - **g)** Net Safe settlement Pressure
   - **h)** Net Allowable Bearing Pressure
2. Write a note on Terzaghi's bearing capacity theory. What are the assumptions made in Terzaghi's bearing capacity theory?
3. Explain the factors effecting the selection of types of foundation.
4. State different types of shallow foundation.
5. Differentiate between shallow foundation and deep foundation.
6. Draw neat sketch of followings (i) Raft Foundation (ii) well foundation (iii) cofferdams (iv) Strip footing (v) strap footing (vi) spread footing (vii) R.C.C. footing
7. Enumerate the factors affecting bearing capacity and explain any two in detail.
8. Discuss bearing capacity from standard penetration test.
9. Discuss bearing capacity Based on IS- Code Method.
10. Determine the ultimate bearing capacity of a strip footing, 1.2 m wide and having the depth of foundation

of 1 m. use Terzaghi's theory and assume general shear failure, take $\phi' = 35°$, $\gamma = 18$ kN/m^3, and c'= 15 kN/m^2.

Ans. 2070 kN/m^2.

11. A footing 2 m square is laid at a depth of 1.3 m below the ground surface. Determine the net ultimate bearing capacity using IS Code method. take $\phi' = 30°$, $\gamma = 20$ kN/m^3, and c'= 0 kN/m^2.

Ans. **q_{nu} =1000 kN/m^2**

12. A strip footing of 2 m width is founded at a depth of 4 m below the ground surface. Determine the net ultimate bearing capacity using (a) Terzaghi's equation (b) Kempton's equation and (c) IS code method. The unit weight of the soil is 20 kN/m^3.

Ans. (a) **Terzaghi's q_{nu} =57 kN/m^2** (b) Kempton's **q_{nu} =70 kN/m^2** (c) **q_{nu} =71.96 kN/m^2**

13. Classify the different types of pile.

14. Differentiate between pile foundation and shallow foundation.

15. What is negative skin friction? What is its effect on pile?

16. Discuss various dynamic formulas. What are their limitations?

17. How to estimate the load carrying capacity of a pile in Cohesionless and cohesive soil?

18. How would you estimate the group capacity of piles in sand and clay?

19. Write a note on under reamed pile and also gives codal provisions for under reamed pile.

20. Gives methods to determine the pile capacity and explain any two.

21. Write a note on group action and efficiency of pile group.

22. A square concrete pile 30 cm x 30 cm is driven in to homogeneous sand layer, ($\phi' = 30°$, $\gamma = 18$ kN/m^3) for a depth of 12 m. calculate the ultimate load. Take K=1.3, $\delta = 18°$.

Ans: Qu= 611.81 kN.

23. A group of friction pile in clay consists of 15 piles of 500 mm diameter grouped as 5x3 spaced at 1m apart. If the undrained shear strength of clay is 0.3 N/cm^2 and piles are 20 m long, estimate the group capacity and its efficiency.

Ans. Pile group capacity = 1143.75 kN and Pile group efficiency= 56.70%