

Code No: 09A50104

R09

SET-1

B. Tech III Year I Semester Examinations, December-2011
GEOTECHNICAL ENGINEERING-I
(CIVIL ENGINEERING)

Time: 3 hours

Max. Marks: 75

Answer any five questions
All questions carry equal marks

- 1.a) Derive from fundamentals: $e_s = G_w$, where 's' represents degree of saturation, 'e' represents void ratio, 'w' represents water content, and 'G' represents grain specific gravity.
- b) The dry unit weight of a sand sample in the loosest state is 13.34 kN/m^3 and in the densest state, it is 21.19 kN/m^3 . Determine the density index of this sand when it has a porosity of 33%. Assume the grain specific gravity as 2.68. [7+8]
2. a) Define and distinguish the following in terms of their use in soil engineering:
i) Consistency Index and Liquidity Index
ii) Flow Index and Toughness Index
- b) A soil sample has a liquid limit of 20% and plastic limit of 12%. The following data are also available from sieve analysis:

Sieve Size (mm)	2.0	0.425	0.075
% Passing	100	85	38

- Classify the soil approximately according to Indian Standard Classification. [7+8]
3. a) Define and distinguish the following:
i) adsorbed & absorbed water ii) Discharge velocity & Seepage velocity.
- b) A bed of sand consists of three horizontal layers of equal thickness. The magnitude of the coefficient of permeability for both the upper and lower layer is $7 \times 10^{-5} \text{ mm/s}$ and for the middle layer is $3 \times 10^{-3} \text{ mm/s}$. What is the ratio of the average permeability of the bed in the horizontal direction to that in the vertical direction? [7+8]
4. a) Demonstrate the quick sand condition with a neat sketch and derive the expression for critical hydraulic gradient.
- b) An earth dam of 80 m wide is built on an impervious foundation with a horizontal filter at the base near the toe. The permeability of the soil in the horizontal and vertical directions is $8 \times 10^{-3} \text{ mm/s}$ and $2 \times 10^{-3} \text{ mm/s}$ respectively. The full reservoir level is 40 m above the filter. A flow net constructed for the transformed section of the dam, consists of four flow channels and 12 head drops. Estimate the seepage loss for the entire length of dam. [7+8]

5. a) Discuss the construction of Newmark's influence chart for vertical stress estimation.
- b) A light house is constructed on a circular ring type foundation. The intensity of loading on the foundation is 200 kPa. The outer diameter of the ring foundation is 16m and the internal diameter is 12m. Determine the vertical pressure directly below the centre of the foundation at depths of 4m and 6m. [7+8]
6. a) Write brief notes on 'compaction' and 'consolidation' of soils and differentiate the two.
- b) Discuss how quality control of compacted earth mass is ensured in the in-situ. [7+8]
7. a) Define the following:
- i) Under consolidated soil
 - ii) Normally consolidated soil and
 - iii) Over consolidated soil. Also discuss the reasons for over consolidation of soil.
- b) There is a bed of compressible clay of 4 m thickness with pervious sand on top and impervious rock at the bottom. Consolidation test conducted on an undisturbed specimen of clay of 20 mm thick obtained from the same deposit showed that 90% settlement has reached in 4 hours. Estimate the time in years for the building founded over this deposit to reach 90% of its final settlement. [7+8]
8. a) What are the drained and undrained shear tests? Under what conditions should the drained shear strength or the undrained shear strength parameters are used? Explain.
- b) The following results were obtained at failure in series of triaxial compression tests, on specimens of clay. Determine the values of shear strength parameters c and ϕ either by drawing the Mohr circles or analytically. [7+8]

Confining Pressure (σ_3), kPa	150	300	450
Deviator Stress (σ_d), kPa	192	341	504

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- 1.a) Define and write the suitable expressions for the following terms: (i) saturated unit weight (ii) bulk unit weight (iii) dry unit weight and (iv) unit weight of solids.
- b) The porosity of a soil sample is 40% and the specific gravity of its particles is 2.65. Calculate its void ratio, dry unit weight, saturated unit weight and submerged unit weight. Also calculate the bulk unit weight of soil, if its degree of saturation is 60%. [7+8]
- 2.a) Define and distinguish the following: (i) liquidity index & consistency index and (ii) uniformly graded soil & well graded soil.
- b) A certain soil has 99% by weight finer than 1mm, 80% finer than 0.1mm, 25% finer than 0.01mm and 8% finer than 0.001mm. Sketch the grain size distribution curve and determine the % of sand as per the IS nomenclature. Also determine the Hazen's effective size and uniformity coefficient. [7+8]
- 3.a) What is permeability? Discuss the various factors that affect the permeability of soil.
- b) A sample in a variable head permeameter is 100 mm in diameter and 120 mm high. The permeability of the sample estimated to be 10×10^{-4} mm/s. if it is desired that the head in the stand pipe should fall from 250 mm to 100 mm in 180 s, determine the size of the stand pipe which should be used. [7+8]
- 4.a) Define (i) total stress, (ii) effective stress, (iii) pore water pressure and (iv) capillary rise.
- b) At a given site, the water table is located at the ground surface and the submerged unit weight of soil is 8 kN/m^3 . If water table rises 4m above the ground surface, determine the change in effective stress at 6m below the ground surface. [7+8]
- 5.a) Discuss the assumptions in Boussinesq's and Westergaard's stress distribution theories. Define pressure bulb and explain its importance in soil engineering.
- b) An annular circular raft has outer and inner diameters as 24m and 18m respectively. If the load intensity on the raft is 250 kPa, estimate the increase in vertical stress at a depth of 2m and 4m from the ground surface and exactly below the centre of the raft. [7+8]

- 6.a) What is soil compaction? Discuss the various factors that affect the compaction of soil.
- b) Write a note on various in-situ compaction equipment and their suitability to soils. [7+8]
- 7.a) Define the following: (i) primary consolidation settlement (ii) degree of consolidation (iii) compression index and (iv) maximum drainage path in double drainage system.
- b) What is coefficient of consolidation of soil? Discuss its evaluation procedure with the help of 'square root time fitting method. [7+8]
8. a) What are the various drainage tests in triaxial compression? Discuss failure envelopes of UU, CU and CD tests for saturated clays, normally consolidated and over consolidated clays.
- b) A cylindrical specimen of a saturated soil fails under an axial stress of 150 kPa in an unconfined compression test. The failure plane makes an angle of 55° with the horizontal. Calculate the cohesion and angle of internal friction of the soil. [7+8]

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- 1.a) Defining the terms void ratio, degree of saturation and water content, explain the engineering significance of determining these properties.
- b) The dry unit weight of a sand sample in the loosest state is 13.5 kN/m^3 and in the densest state, it is 21.2 kN/m^3 . Determine the density index of this sand when it has a porosity of 35%. Assume the grain specific gravity as 2.65. [7+8]

- 2.a) Discuss the classification of fine grained soils using IS plasticity chart.
- b) A sieve analysis on a soil sample gave the following results:

Sieve size (mm)	4.75	2.0	0.84	0.42	0.25	0.15	0.075
% Finer	65	55	44	30	24	15	9

Sketch the grain size distribution curve and determine the coefficient of uniformity and coefficient of curvature. [7+8]

- 3.a) Discuss the suitable laboratory method to determine coefficient of permeability of coarse grained soils.
- b) Determine the average horizontal and vertical permeability of a soil mass made up of three horizontal strata, each 2m thick, if the coefficient of permeability are $2 \times 10^{-2} \text{ mm/s}$, $4 \times 10^{-2} \text{ mm/s}$, and $4 \times 10^{-3} \text{ mm/s}$ for the three layers. [7+8]
- 4.a) What is flownet? Discuss the characteristics and uses of flownets.
- b) For a homogeneous earth dam having water head 30m, a flow net was constructed with four flow channels. The number of potential drops was 16. The dam has a horizontal filter at the base near the toe. The coefficient of permeability of the soil was $4 \times 10^{-4} \text{ mm/s}$. Determine the anticipated seepage, if the length of the dam is 120m. [7+8]

5. Discuss the assumptions of Boussinesq's theory. Using Boussinesq's expression, derive the expression for vertical stress at depth 'z' under the centre of a circular area of radius, 'r' loaded uniformly with a load 'q' at the surface of the mass of soil. [15]

- 6.a) Explain why soils are compacted in the field. Discuss how the degree of compaction or relative compaction is ensured in the field?
- b) Explain how zero air void line (ZAVL) is constructed and write its significance in compaction of soil. [7+8]

- 7.a) Define the following: (i) immediate settlement (ii) primary consolidation settlement (iii) secondary consolidation settlement and (iv) over consolidation ratio.
- b) A 2 cm thick sample of clay was taken from field for predicting the times of settlement for a proposed building which exerts a uniform pressure of 200 kN/m^2 over the clay stratum. The sample was loaded to 200 kN/m^2 and proper drainage was allowed from top and bottom. It was seen that 50% of the total settlement occurred in 180 seconds. Find the time required for 50% of the total settlement of the building if it is to stand on 8m thick layer of clay which extends from ground surface and is underlain by sand. [7+8]
- 8.a) What are the advantages and disadvantages of triaxial compression test over direct shear test? Explain.
- b) The following data relate to a triaxial compression tests performed on a soil sample.

Test No.	Cell Pressure (σ_3), kPa	Maximum Deviator Stress (σ_d), kPa
1	80	175
2	150	240
3	210	300

Determine the shear parameters such as cohesion and angle of internal friction from the above data using the relation of σ_1 and σ_3 . [7+8]

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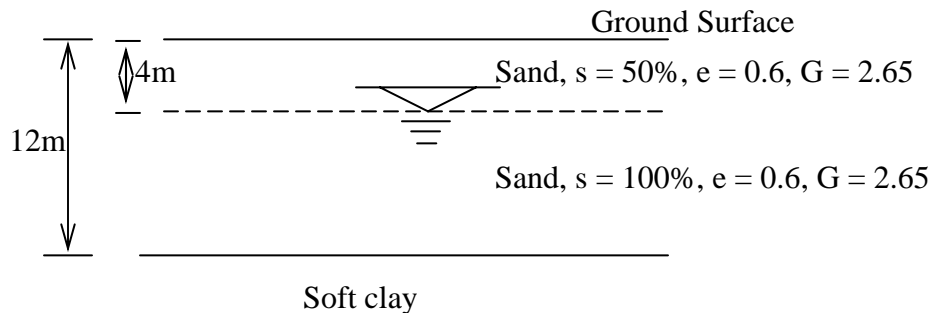
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- 1.a) What are the index and engineering properties of soil? Discuss the various structures of soil.
- b) A sample of saturated soil has a water content of 40%. The specific gravity of solids is 2.65. Determine its void ratio, porosity, saturated unit weight and dry unit weight. [7+8]
- 2.a) Define and distinguish the following in terms of their use in soil engineering:
 i) Liquid Limit and Liquidity Index
 ii) Density and Relative Density
- b) A certain soil has 99% by weight finer than 1mm, 80% finer than 0.1mm, 25% finer than 0.01mm and 8% finer than 0.001mm. Sketch the grain size distribution curve and determine the % of sand as per the IS nomenclature. Also determine the Hazen's effective size and uniformity coefficient. [7+8]
- 3.a) Discuss the following: (i) discharge velocity (ii) seepage velocity (iii) principle of Darcy's law and (iv) effect of void ratio on permeability of soil
- b) A sample in a variable head (falling head) permeameter is 10cm in diameter and 10cm high. The permeability of the sample is estimated to be 4×10^{-4} cm/s. If it is desired that the head in the stand pipe should fall from 25cm to 12cm in 200 seconds, determine the size of the stand pipe which should be used. [7+8]
- 4.a) What is flownet? Write the principles and uses of flow nets.
- b) A sand deposit of 12m thick is lying above the soft clay bed. The water table is 4m below the ground surface. If the sand above the ground water table has 50% degree of saturation, calculate the effective stress at the middle and bottom of the sand layer. [7+8]



- 5.a) Explain the use of 'Newmark's influence chart' in vertical stress estimation in case of irregularly loaded areas.

- b) A raft of the size 4m x 4m carries a uniform load of 180 kN/m². Using the point load approximation with four equivalent point loads, calculate the stress increment at a point in the soil which is 4m below the centre of the loaded area. [7+8]
- 6.a) Write a note on (i) zero air void line (ii) degree of compaction (iii) OMC and MDD and (iv) uses of compaction of soil.
- b) Discuss various factors affecting the compaction of soil. [7+8]
- 7.a) What is preconsolidation pressure? Explain the Casagrande's graphical procedure for its estimation.
- b) At a given site (site A) having a clay layer 4m thick with single drainage, a uniform fill that was constructed resulted in a settlement of 25 mm in 1 year, corresponding to 50% average degree of consolidation. It was found that at a neighboring site (site B), the same type of clay of thickness 9m exists with single drainage. How long will it take for 50% consolidation to occur? [7+8]
- 8.a) What are the three standard triaxial shear tests with respect to drainage conditions? Explain with reasons the situations for which the each test is preferred.
- b) A series of box shear (area of box = 36 cm²) tests were conducted on a soil sample. For the results presented in below table, estimate the 'cohesion' and 'angle of internal friction' of soil. [7+8]

Normal load (N)	90	180	270
Shear load (N)	70	90	117

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