BANGLADESH UNIVERSITY OF PROFESSIONALS
Military Institute of Science and Technology
B.Sc. in Environmental, Water Resources, and Coastal Engineering, Term Final (Spring) Examination 2025: Oct - Nov 2025

Student Group: 72<Earned Credit Hours ≤ 108

Subject: EWCE 341, Principles of Soil Mechanics

Time: 3.00 hours **Full Marks: 180**

INSTRUCTIONS:

a. Use **SEPARATE** answer scripts for each section.
b. **Question-1** in **Section-A** and **Question-5** in **Section-B** are compulsory.
c. Answer any other **TWO** out of the remaining **THREE** questions from each section.
d. Figures in the margin indicate full **marks**.
e. Assume reasonable data if necessary.
f. **Symbols** and **abbreviations** used have their usual meanings.

SECTION-A

Question 1 (Compulsory)

a. Derive an expression for shrinkage limit involving specific gravity of soil solids. **06**

b. Draw typical shear stress – shear strain diagram showing yield strength, peak strength, ultimate strength, critical state strength and residual strength. Also, explain them briefly. **06**

c. Write down the undesirable properties of organic soil. Explain how would you ascertain that a soil is of organic origin. **06**

d. On what circumstances, a soil can be tested in unconfined compression machine to determine its shear strength parameter. Justify your answer. **06**

e. Draw a chart to classify inorganic soil deposits. **06**

Question 2

a. The following data were obtained from a liquid limit test on a silty clay. **15**

Number of blows	35	29	21	15
Moisture content, w%	41.1	41.8	43.5	44.9

Three plastic limit determinations had water contents of 23.1, 23.2 and 23.3. Determine the liquid limit, plasticity index and the flow index of the soil.

b. Consolidated drained triaxial tests were conducted for three similar specimens with different cell pressures and the failure deviatoric stresses were measured as follows: **15**

Cell pressure (kPa)	50	100	200
Deviator stress at failure (kPa)	90	125	165

Determine the shear strength parameters of the soil. Explain whether the soil is normally consolidated or overconsolidated.

Question 3

a. Assume that both a triaxial shear test and a direct shear test are to be performed on a sample of dry sand. When the triaxial shear test is performed, the specimen fails at the major and minor principal stresses of 550 kPa and 150 kPa, respectively. When the direct shear test is performed, what shear strength can be expected if the normal stress is 190 kPa? Use Mohr's circle diagram. **15**

b. The sieve analysis of a soil revealed that 58% of the particles are finer than 75 μm. The liquid limit and plastic limit of the soil were 61% and 27%, respectively. Classify the soil as per the AASHTO system inclusive of group index. Comment on the suitability of the soil to be used as subgrade of a road embankment. **15**

Question 4

a. A consolidated undrained triaxial test was performed on a normally consolidated saturated clay soil. The cell pressure was 100 kPa. The deviator stress at failure was 60 kPa. The excess porewater pressure was measured during the test and at failure it was kPa. Using Mohr's circle diagram, determine the undrained shear strength at failure. Also, determine the drained shear strength parameter of the soil. **15**

b. Particle size analyses were carried out on two soils, soil A and soil B, and the particle size distribution curves are shown in Figure 1. The Atterberg limits for the two soils are as under. Classify these soils according to USCS. **15**
Soil A: Liquid limit = 52, Plastic limit = 26
Soil B: Liquid limit = 36, Plastic limit = 18

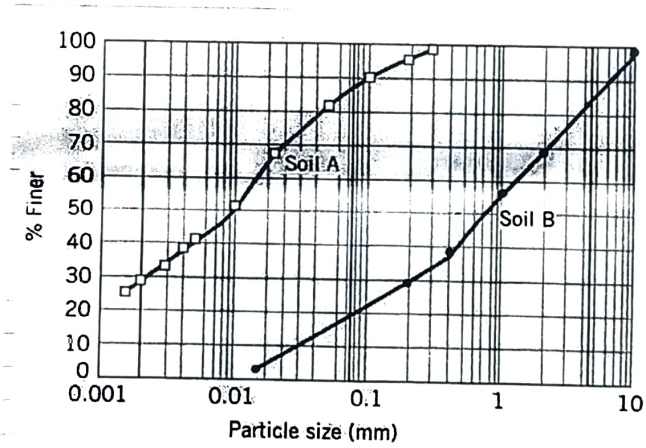


Figure 1 for question No. 4 (b)

SECTION-B

Question 5 (Compulsory)

a. Define geotechnical engineering. Write down importance of studying geotechnical engineering. State the different issues to be addressed by geotechnical engineers in civil engineering infrastructure constructions. **05**

b. Write down the meaning of soil compaction. Briefly explain how the compaction improves the different engineering properties of soils. Explain why the dry unit of soils (γ_d) is an important parameters for soil compaction. **05**

c. Explain the shear failures in soils. Briefly describe the different modes of bearing capacity failures in soils. **05**

d. Define soil settlement. Describe in brief the different types of soil settlement. **05**

e. Define the permeability of soils. Explain why the permeability is an important engineering property of soils. Write down the factors that affect the permeability of soils. **05**

f. Write down your understanding about the flownet of seepage of water below the concrete dam. Explain the different aspects which can be studied by the construction of flownet. Describe the properties of flownet. **05**

Question 6

a. Define the gas phase in soils. Briefly describe the hazardous effects of gases in soils. **05**

b. A certain soils has the following properties: **10**
$G_s = 2.73$
$\eta = 38\ \%$
$w = 18\%$
Using the phase diagram of soils, compute the degree of saturation (S), void ratio (e) and dry unit weight of soils (γ_d).

c. Describe the Darcy's law for the flow of free water through soils. Define the coefficient of permeability of soils. Write down the limitations of Darcy's law for flow of water through the different types of soils. **05**

d. A permeable soil layer is underlain by the impervious soil layers shown in the following Figure 2. Following data were obtained about the permeable layer: **10**
Height = 5.5 m
Width = 1000 m
$k = 3.2 \times 10^{-3}$ cm/sec.
Inclination $\alpha = 8.5°$
Compute the total seepage per month through the permeable layer.

Question 7

a. Briefly describe the elastic parameters of soils. Write down the simplifying assumptions to compute stresses in soils. **05**

b. Compute the $\Delta\sigma$ at a depth of 10 m below the edge of a 25 m dia and 3 m thick RCC circular footing of a water tank. The unit weight of RCC is 25 kN/m^3. The water tank including water has a total mass of 24×10^5 kg. If the unit weight of soils is 17.8 kN/m^3, calculate the total stress in soil at the same depth of footing. **10**

c. Briefly explain physical process of consolidation and its relation with flow of porewater by piston and spring analogy. **10**

d. A proposed fill with unit weight of 20 kN/m^3 is to be placed over the soils whose profile is shown in following Figure 3. Compute the total effective stress at point M in the soil profile before and after placing of the compacted fill. **05**

Question 8

a. Explain the effects of soil sampling in the consolidation test results. Briefly describe the Schmertmann's procedure to reconstruct the consolidation curves obtained from laboratory test data. **07**

b. For the given consolidation curves in following Figure 4, determine the stress σ_c' in kPa using Casagrande procedure. Also compute the compression index C_c and recompression index C_r (1 tsf = 96.76 kPa). (Figure 4 can be attached with answer script.) **08**

c. Draw a flownet below a sheet pile and prove that the same quantity of water flows through each of the flow element and there is same head lost in crossing each flow element if all the flow elements are squares or poses same width to length ratio. **08**

d. The flow net constructed for the dam is shown in the following Figure 5. The coefficient of permeability of the soils is 3.8 m $\times$ 10^{-8} m/sec. Determine the quantity of flow in in m^3/month under the dam per meter of dam and porewater pressure at point A in the flownet. **07**

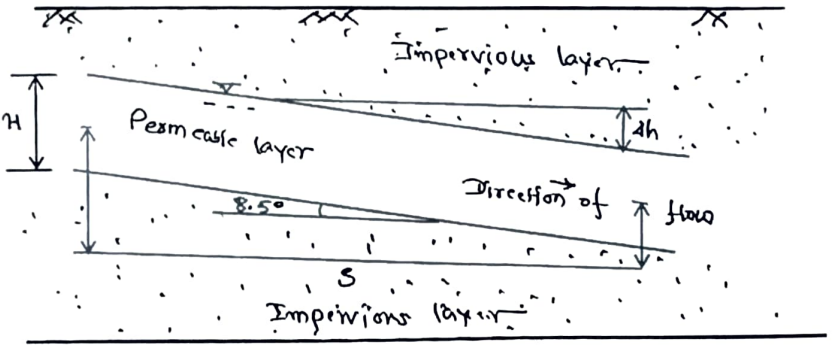


Figure 2: Permeable soil layers underlain by impermeable soil layers (for Question 6(d))

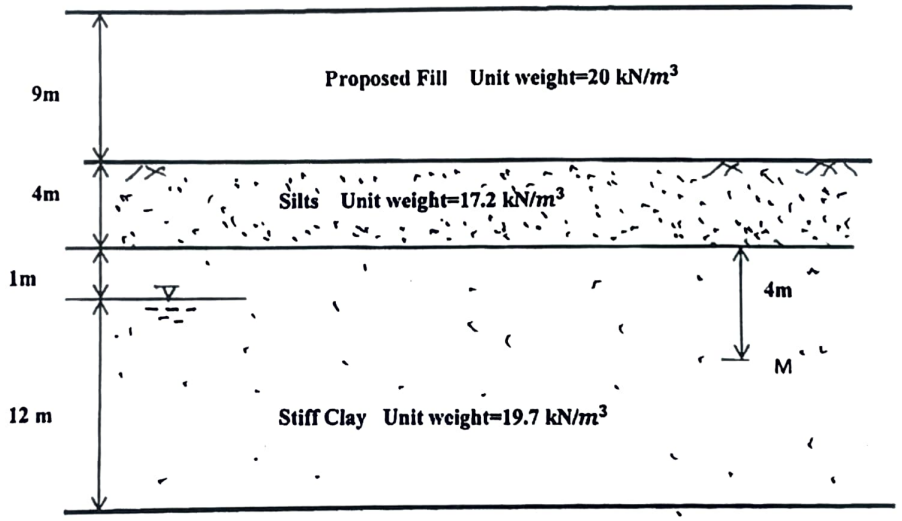


Figure 3: Soil profile over which a proposed fill is placed (for Question 7(d))

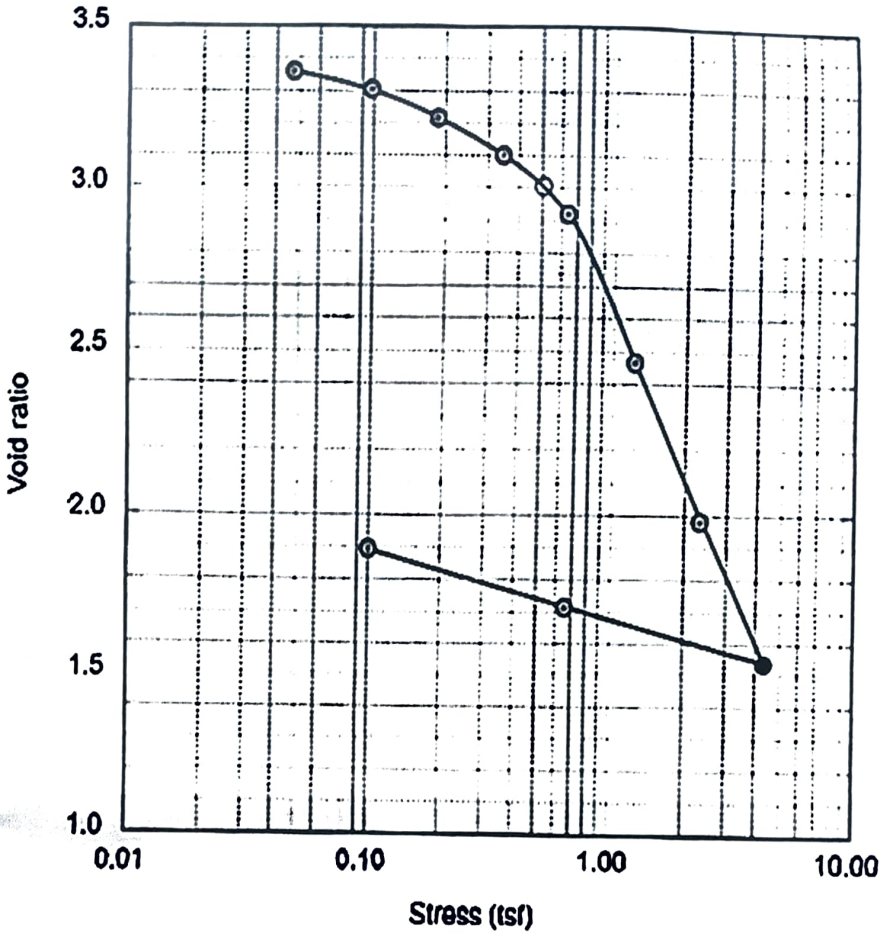


Figure 4: Consolidation Curves (for Question 8(b))

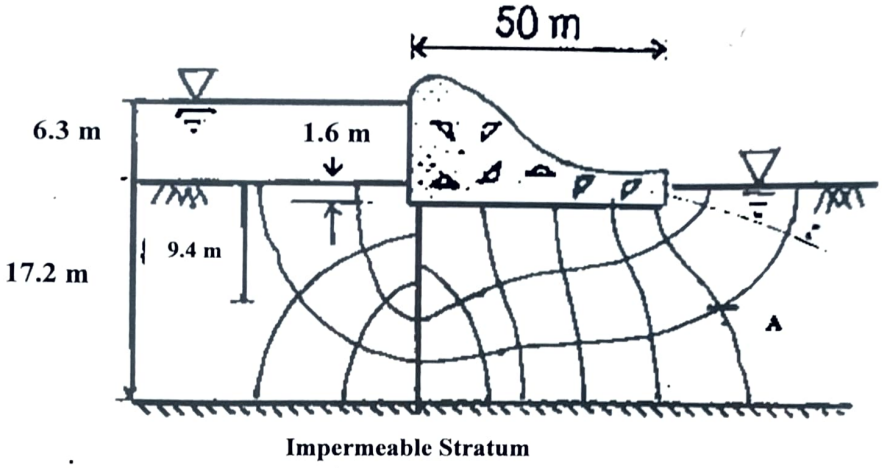
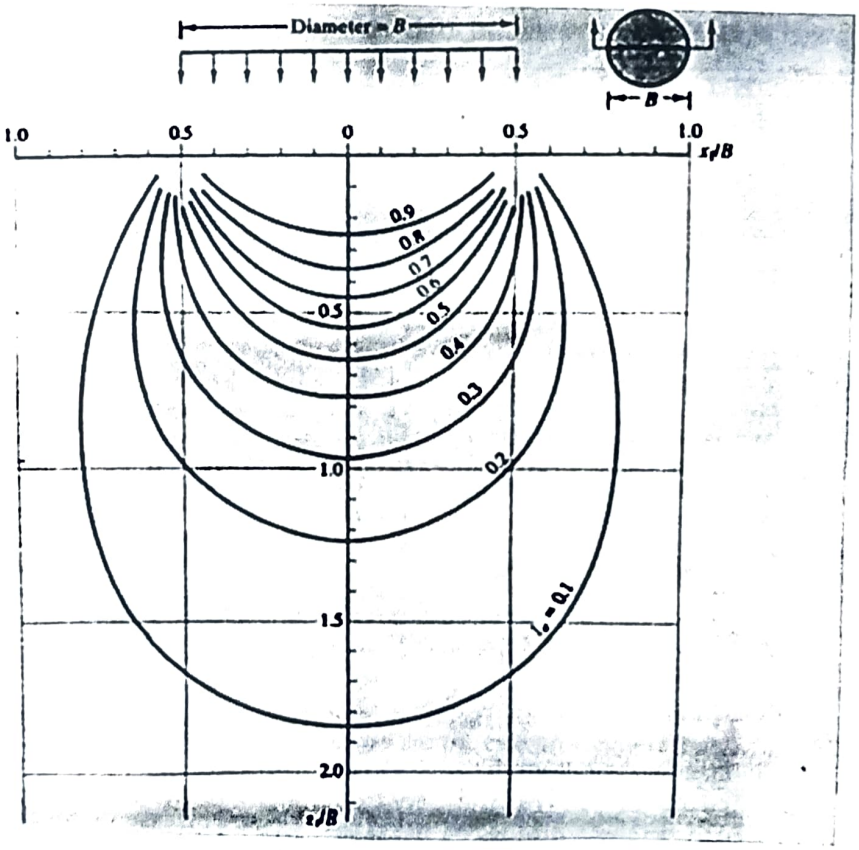


Figure 5: Flow net constructed under a dam (for Question 8 (d))



Pressure bulb for the loaded area of circular footing