University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2013
Program: B.Sc. Engineering (Civil)

Course Title: Geotechnical Engineering I   Course Code: CE 341
Time: 3 hours   Full Marks: 100

Section A
There are 5 questions. Answer any 4 questions.   (4x10=40 marks)

1. a) Define: (i) Specific gravity, (ii) Porosity, (iii) Hydraulic gradient   3
   b) Derive the expression relating degree of saturation (S), void ratio (e), water content (w) and specific gravity (G_s).   4
   c) Compare (qualitatively) T_{60} (time factor for 60% consolidation), t_{60} (time required for 60% consolidation), c_v (coefficient of consolidation) between the two cases of boundary condition for a given clay soil: (i) clay layer exists in between two sand layers, (ii) clay layer exists in between a sand layer and an impervious layer. What is the difference in drainage condition during consolidation in both cases?   3

2. a) Define: (i) Effective size, (ii) Plasticity Index, (iii) Effective stress   3
   b) How is the total soil stress increased? Mention two causes only.   2
   c) Describe the effect of particle sizes on the behaviour of coarse grained and fine grained soils.   2
   d) Identify at-rest, active and passive cases for the given conditions: (i) retaining wall is moving away from the backfill material, (ii) retaining wall is moving towards the backfill material, and (iii) retaining wall is not moving at all.   1.5
   e) Write on secondary consolidation process. When can it be expected (before or after primary consolidation)? Which type of soil may experience secondary consolidation settlement?   1.5

3. a) Define: (i) OCR, (ii) Swelling index, (iii) OMC   3
   b) Differentiate the three types (CU, UU and CD) of Triaxial tests.   3
   c) Discuss on the Mohr-Coulomb failure envelop and the shear strength parameters.   2
   d) Write on total stress, effective stress and pore water pressure in a soil medium.   2

4. a) Write on different laboratory tests of fine grained soil. Which tests are required to classify a fine grained soil according to unified soil classification system?   3
   b) What is Darcy's Law and mention about its validity for all three types of flow (laminar, transitional and turbulent)?   2
   c) Calculate the time required to complete 90% consolidation for a 5 m deep saturated clay layer which is subjected to one-way drainage. Given that a sample from the mid depth from the clay layer was found to complete 60% of primary consolidation settlement in 48 hours during one dimensional oedometer test in the laboratory.   4
   d) Name the laboratory tests for consolidation, compaction and permeability (for coarse grained and fine grained soils).   1
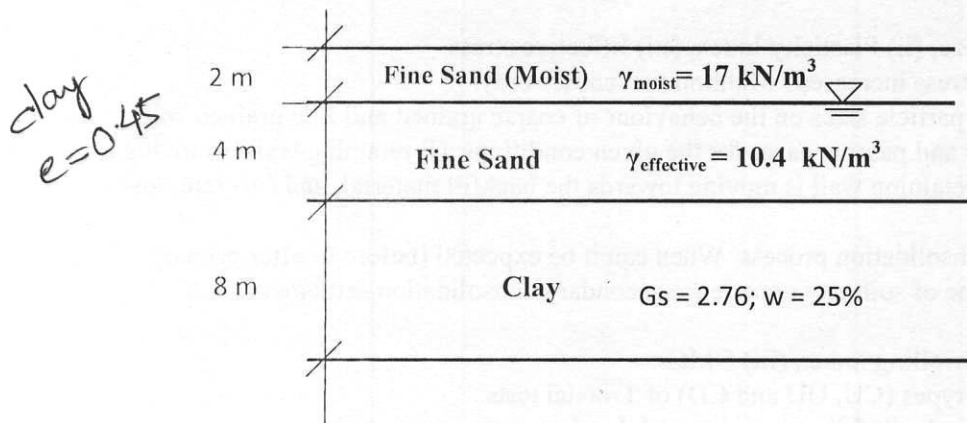
5. a) Pre-consolidation pressure at the mid level of a given saturated clay layer is found 500 psf. Classify the clay soils for the following cases: (i) When present overburden pressure is 450 psf, (ii) When present overburden pressure is 500 psf, and (iii) When present overburden pressure is increased to 700 psf. In which case pre-consolidation pressure is not 500 psf and what is the new value of pre-consolidation pressure?   2.5

b) Discuss on the particle size distribution curve and the constants derived from this curve.   2.5

c) Derive the expression of the coefficient of active earth pressure as a function of angle of internal friction (φ) for cohessionless soil.   5

Section B
There are eight questions. Answer any 6 questions.   (6x10 = 60 marks)

6. A clay stratum of thickness 8 m is located at a depth of 6 m below the ground surface. It is overlain by fine sand. The water table is located at a depth of 2 m below the ground surface. For fine sand, effective unit weight is 10.4 kN/m³. The moist unit weight of sand located above water table is 17 kN/m³. For clay layer, G_s = 2.76 and water content (w) is 25%. Compute the effective stress, the total stress and the pore water pressure at the bottom of the clay layer.

clay
e=0.45

2 m	Fine Sand (Moist) γ_{moist}= 17 kN/m³
4 m	Fine Sand $\gamma_{effective}$ = 10.4 kN/m³
8 m	Clay Gs = 2.76; w = 25%

7. A concentrated load, 90 kN, acts on the surface of a soil mass. Using Boussinesq analysis $[\sigma_z = \frac{3Q.z^3}{2\pi.(r^2+z^2)^{5/2}}]$, (a) Find the vertical stresses for the following points:
(i) 2 m below the surface along the axis of loading;
(ii) 2 m below the surface and 3 m (radial distance) away from the load and
(iii) 2 m below the surface and 6 m (radial distance) away from the load
(b) Draw the horizontal stress distribution at a depth of 2 m using the stresses calculated for the given problem.
(c) Also draw the horizontal stress distribution at a depth of 6m. The magnitudes of stresses are not required.

8. (a) Classify subgrade soil A.
The properties of a subgrade soil (A) are found as follows:
Percent finer than 0.075 mm = 20%
Percent finer than 0.425 mm = 25%
Percent finer than 0.6 mm = 32%
Percent finer than 4.75 mm = 75%
Liquid limit = 52% & Plastic limit = 35%

(b) The properties of a subgrade soil (B) are found as follows:
Percent of soil material in the pan = 4%

60% of the total soil material having a diameter less than 4.75 mm
30% of the total soil material having a diameter less than 1.18 mm
10% of the total soil material having a diameter less than 0.3 mm
Liquid limit = 33% & Plasticity index = 0%
What is the effective size of the soil? Calculate coefficient of curvature and plastic limit of the soil. Is the soil cohesive or cohesionless? Is it possible to observe this soil in plastic state?

9. Find the magnitude and location of the active force (per unit width) on the retaining wall, shown below, for the Rankine state.
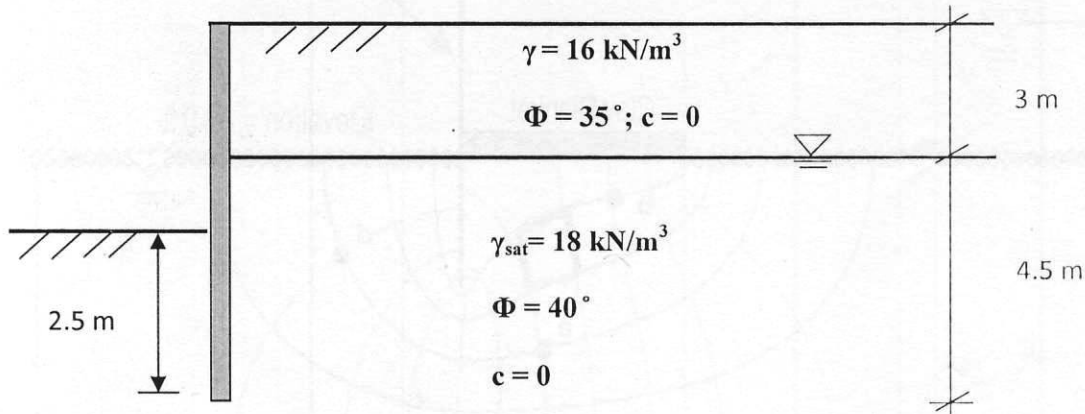
10. The following table gives data obtained from a direct shear test conducted on samples of compacted sand. The cross-section of the shear box is 60 mm x 60 mm. Plot the Mohr Coulomb failure envelop and determine the values of the shear strength parameters for the data given in the table. Use graph paper. Units of all parameters must be mentioned.

| Normal Load (kN)	Shear Load (kN)
60	95
160	195
260	294

11. The following observations were made in a Standard Proctor Test.

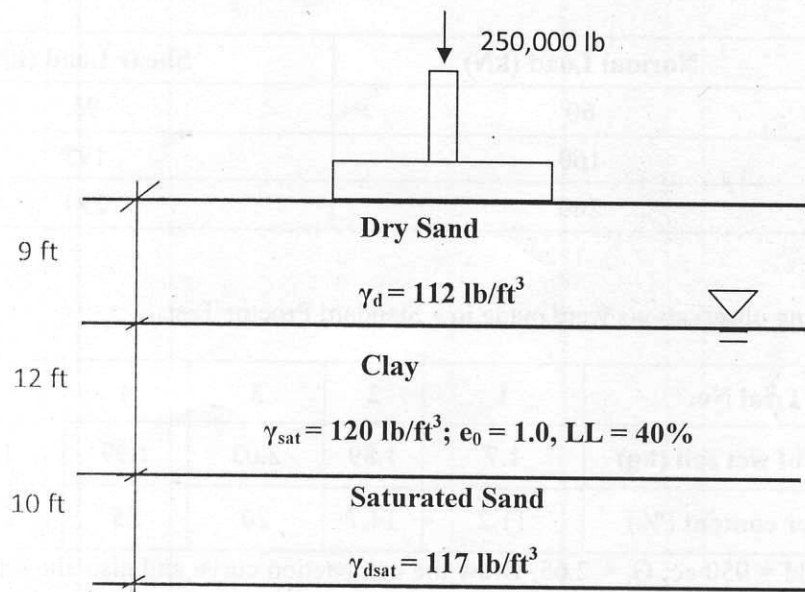| Trial No.	1	2	3	4	5	6
Mass of wet soil (kg)	1.7	1.89	2.03	1.99	1.96	1.92
Water content (%)	11.2	14.7	20	25	27.8	33.1

Volume of Mold = 950 cc; G_s = 2.65. Draw the compaction curve and also show the zero air void line on the graph. Determine maximum dry density and optimum moisture content.

12. Calculate the following for the seepage flow shown below. (a) Heights of water in the piezometer, if installed at a, b, c and d; (b) Hydraulic gradient, i for the flow element highlighted in the figure. The flow element is an approximate square having 4 ft of each side; (c) Total seepage flow rate.

$k = 0.025 \ ft/s$

Elevation= 45 ft

Sheetpile Wall

Clay Blanket

Elevation = 32.0 ft

b

d

a

c
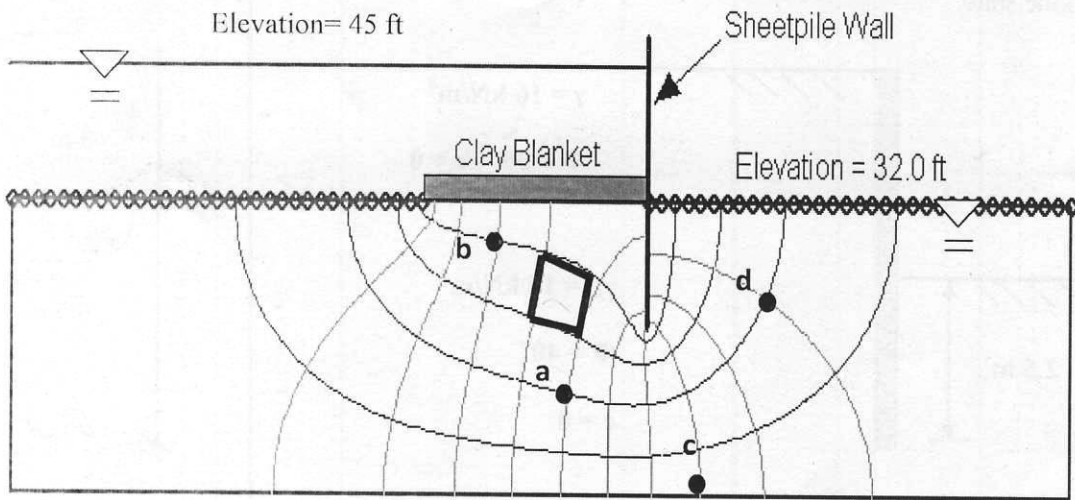
13. Calculate the primary consolidation settlement for the 12 ft thick clay layer (as shown below) due to the load carried by a square footing of size 7 ft x 7ft. The clay is normally consolidated. Use the average method to calculate the average increase of pressure in the clay layer.

250,000 lb

9 ft

Dry Sand

$\gamma_d = 112 \ lb/ft^3$

12 ft

Clay

$\gamma_{sat} = 120 \ lb/ft^3$; $e_0 = 1.0$, LL = 40%

10 ft

Saturated Sand

$\gamma_{dsat} = 117 \ lb/ft^3$

Given that: $C_c = 0.009(LL - 10)$; Stress increase at the top of the clay layer, $\Delta\sigma_t = 0.055 * \sigma_{applied}$; Stress increase at the middle of the clay layer, $\Delta\sigma_m = 0.028 * \sigma_{applied}$; Stress increase at the bottom of the clay layer, $\Delta\sigma_b = 0.02 * \sigma_{applied}$; Average stress increase, $\Delta\sigma = (2 \Delta\sigma_t + 4 \Delta\sigma_m + 3 \Delta\sigma_b) / 9$