University of Asia Pacific
Department of Civil Engineering
Final Examination Fall 2012
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)

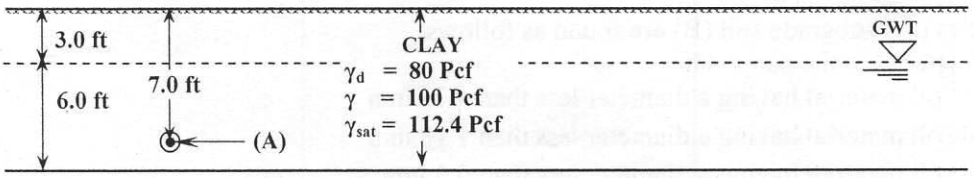
1. a) Define: (i) Effective unit weight, (ii) Degree of saturation, (iii) Hydraulic gradient 3
   b) Derive the expression relating degree of saturation (S), void ratio (e), water content (w) and specific gravity (G_s). 4
   c) Discuss on the effects of compaction on soil properties. 3

2. a) Define: (i) Effective size, (ii) Plasticity Index, (iii) Void ratio 3
   b) Derive the expression of equivalent coefficient of permeability ($k_{H(eq)}$) for flow in the horizontal direction for three layers of soil with horizontal stratification. 4
   c) Describe the role of moisture content in soil compaction. 3

3. a) Define: (i) OCR, (ii) Compression index, (iii) OMC 3
   b) Discuss on different states of soil and limiting water contents (Atterberg's limits). 2
   c) Name three shear strength tests and their applicability for different types of soil. 3
   d) Write short notes on coefficients of earth pressure at-rest. 2

4. a) Wrie the Bernoulli's equation for soil media 3
   b) What is Darcy's Law and mention about its validity for all three types of flow (laminar, transition and turbulent)? 2
   c) Derive the expression of the coefficient of passive earth pressure as a function of angle of internal friction (φ) for cohessionless soil. 5

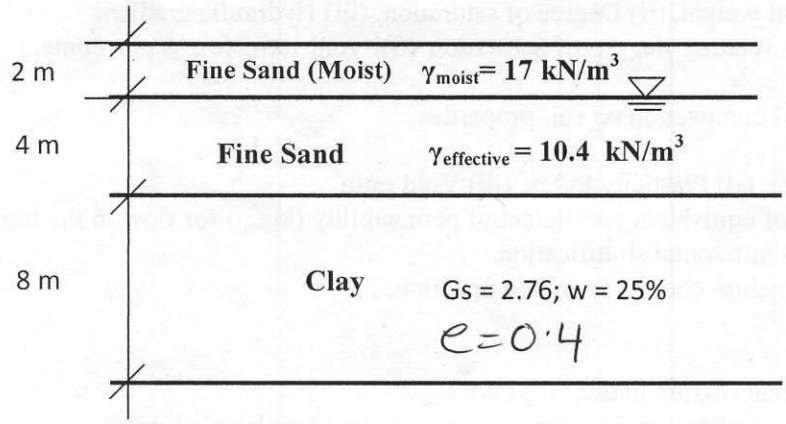
5. a) Define: (i) Uniformity coefficient, (ii) Coefficient of consolidation, (iii) Liquid limit 3
   b) Calculate the time required to complete 60% consolidation for a 5 m deep saturated clay layer which is subjected to one-way drainage. Given that a sample from the mid depth from the clay layer was found to complete 60% of primary consolidation settlement in 3 days during one dimensional oedometer test. 3
   c) Pre-consolidation pressure for a soil sample obtained from location A is found to be 700 psf. Find whether it is a normally consolidated or over-consolidated soil. 4



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/m^3. The moist unit weight of sand located above water table is 17 kN/m^3. 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.



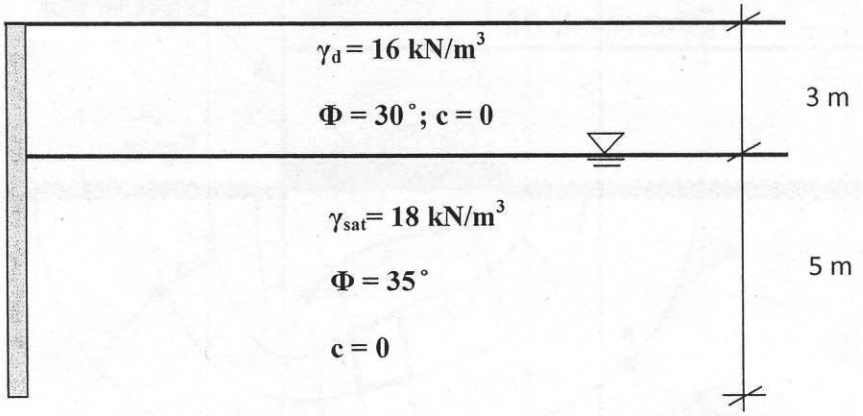
7. A concentrated load, 18 kN, acts on the surface of a soil mass. Using Boussinesq analysis [$\sigma_z = \frac{3Q.z^3}{2\pi.(r^2+z^2)^{5/2}}$], find the vertical stresses for the following points:
(i) 4 m below the surface on the axis of loading;
(ii) 4 m below the surface and 3 m (radial distance) away from the load and
(iii) 8 m below the surface and 3 m (radial distance) away from the load.

8. Classify the following soils:

(a) The properties of a subgrade soil (A) are found as follows:
Percent finer than 0.075 mm = 15%
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% & Plastic limit = 0%

9. Find the magnitude and the 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.

Normal Load (kN/m^2)	Shear Load (kN/m^2)
110	95
225	195
340	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 (%)	7.7	11.5	14.6	17.5	19.7	21.2

Volume of Mold = 950 cc; $G_s = 2.65$.
Determine maximum dry density and optimum moisture content.

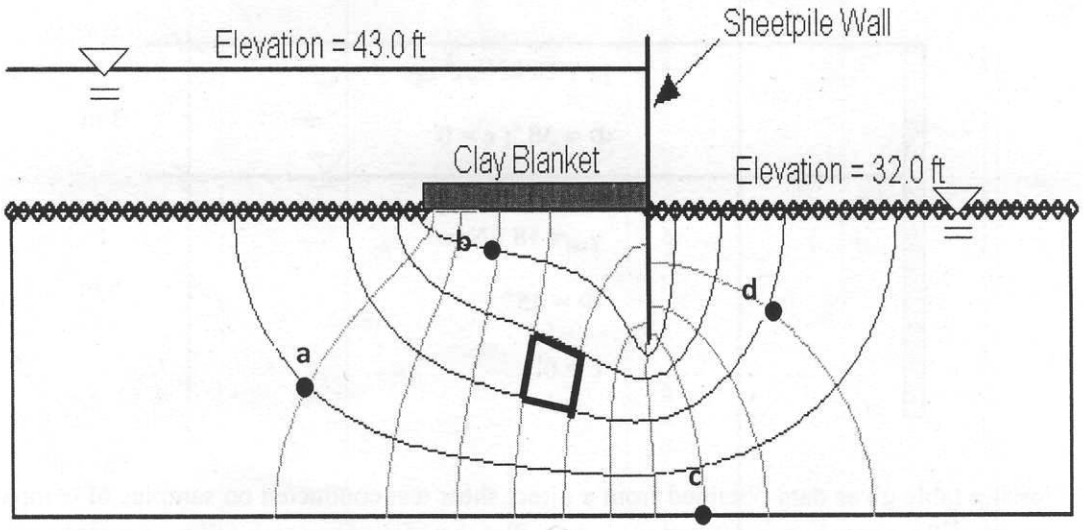
12. Calculate the following for the seepage flow shown below:

(a) Heights of water in the piezometer, if installed at a and b.

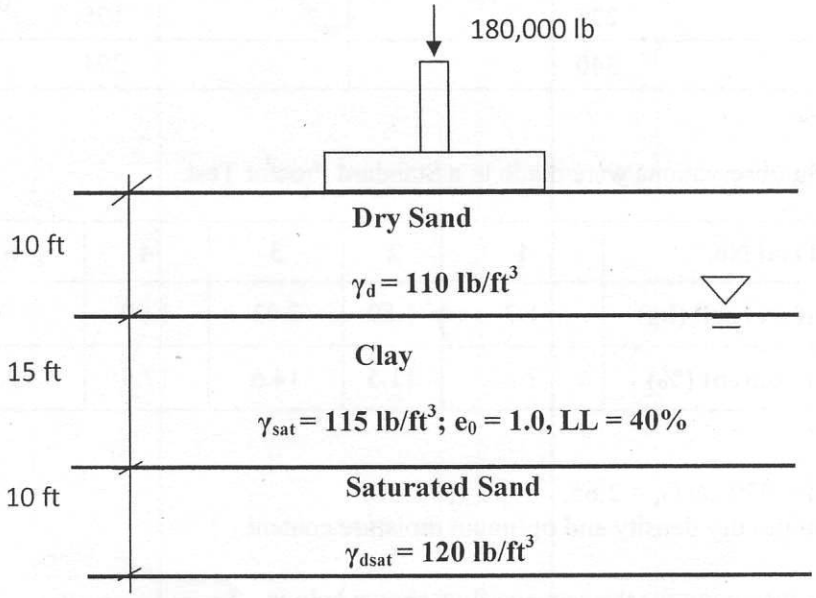
(b) Hydraulic gradient, i for the flow element highlighted in the figure. The flow element is an approximate square having 6 ft of each side.

(c) Flow rate through the flow channels between point a and point b.

$K = 5 \times 10^{-4}$ cm/s



13. Calculate the primary consolidation settlement for the 15 ft thick clay layer (as shown below) due to the load carried by a square footing of size 5 ft x 5ft. The clay is normally consolidated. Use the average method to calculate the average increase of pressure in the clay layer.



Given that: Cc = 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, $\Delta\sigma = (2\,\Delta\sigma_t + 4\,\Delta\sigma_m + 3\,\Delta\sigma_b) / 9$