University of Asia Pacific
Department of Civil Engineering
Final Examination Fall – 2012
Program: B. Sc. Engineering (Civil)

Course Title: Geotechnical Engineering II — Course Code: CE 441
Time: 3 hours — Full Marks: 120 (20 X 6 = 120

Answer any 6 (six) of the following 8 (eight) questions

1. **(a)** Mention four purposes of geotechnical subsurface exploration. 4

   (b) Write down any two general guidelines (GG) used for the selection of depth and location of boreholes for civil engineering projects. 4

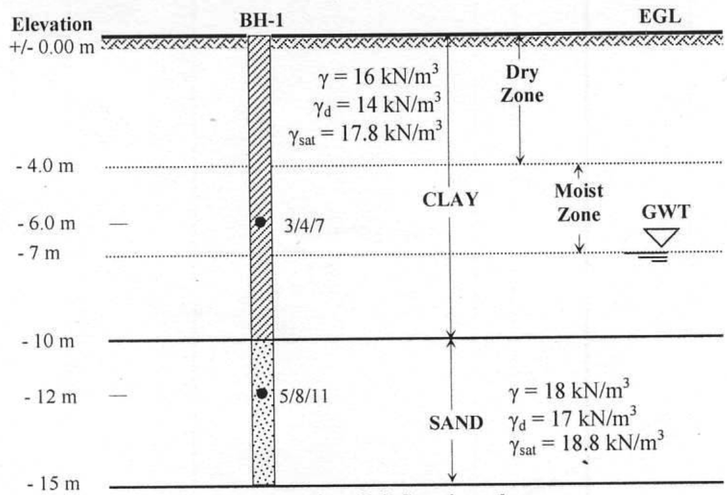
   (c) Mention the name of the in-situ test most frequently used in Bangladesh. Write a short note on this test. 1 + 5 = 6

   (d) Write short notes (any two) on: (i) Ground water table (ii) Logging and sampling (iii) Site reconnaissance. 3 x 2 = 6

2. **(a)** The outside and inside diameters of a split-spoon sampler are 50.8 mm and 34.93 mm, respectively. The outside and inside diameters of a Shelby tube sampler are 76.2 mm and 73 mm, respectively. Estimate the degree of disturbances for two soil samples; one obtained using the split-spoon sampler and the other using the Shelby tube. Also determine whether the samples are disturbed or undisturbed. 4

   (b) An eight-inch diameter borehole (**BH-1**) was advanced at a site under the scope of a **preliminary** geotechnical sub-surface exploration program. Determine the Field SPT-N values at elevations -6 m and -12 m. Apply necessary corrections, as required, and determine the corrected SPT values (Use Appendix as necessary). Also estimate the shear strength parameters as necessary at corresponding depths. 8

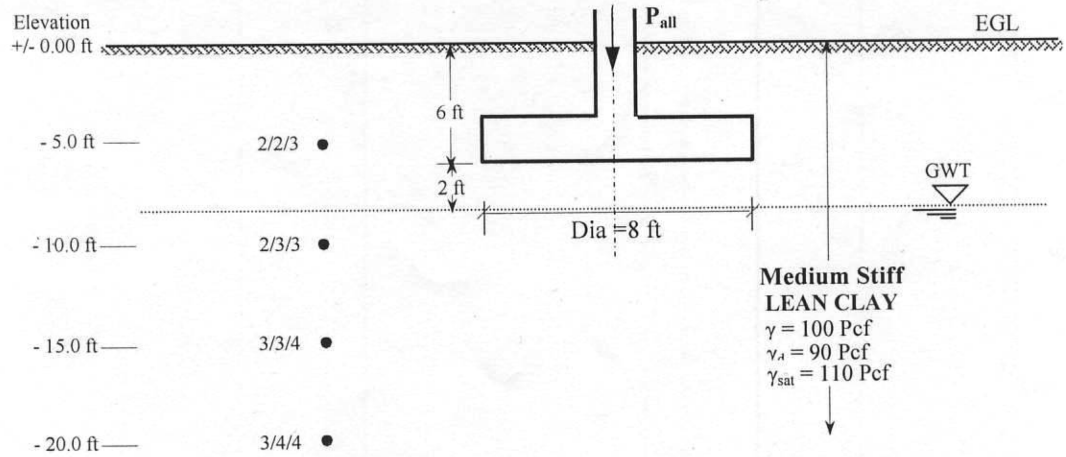
   Notes: - Wash Boring method was used.
   - Hammer efficiency = 70%.
   - Standard sampler was used during sampling.



Subsurface Soil Stratigraphy

   (c) From a preliminary field investigation, the subsurface condition obtained is shown in the figure below. SPT-N values were obtained at each 5-foot depth intervals. Using Terzaghi's bearing capacity equation (as appropriate), determine the allowable column load (P_{all}) for the individual column circular footing founded as shown below. Use F.S =3. 8

NOTE: No laboratory tests were conducted to obtain the shear strength of the clay formation. So, use empirical correlation to estimate the average shear strength below the foundation level.



3. (**a**) Using Terzaghi's bearing capacity equation, an entry-level engineer designed a square foundation for a column load of 170 kN for the soil conditions (Medium dense) as shown in the following FIGURE (A). In his design he did not consider the effect of ground water condition. Other than that his calculations were correct and the footing size was found to be 1.5 m X 1.5 m with a FS = 3. Use γ_w as $10 kN/m^3$. 10

His design was not properly reviewed and the structure was constructed. The site investigation revealed that the GW was at the EGL. You are now involved in reviewing his design. Considering the actual GW condition as shown in **FIGURE (B)**, what would be the actual ultimate load (P_u) that the column can take? Also calculate the actual FS the structure is having now.

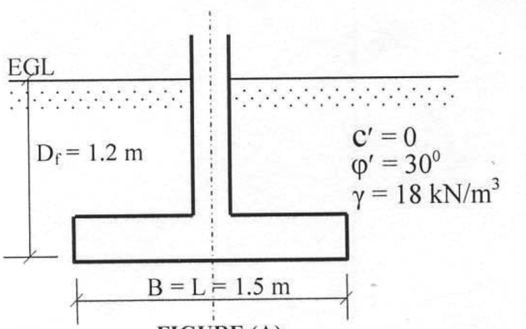


FIGURE (A)

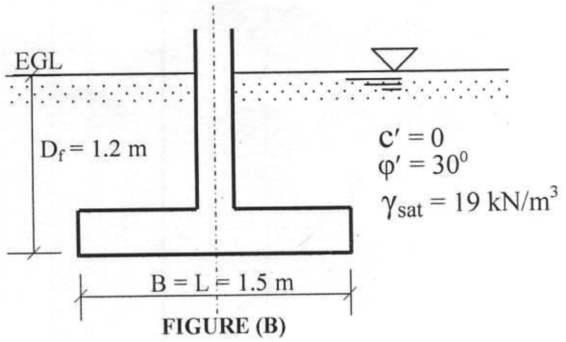
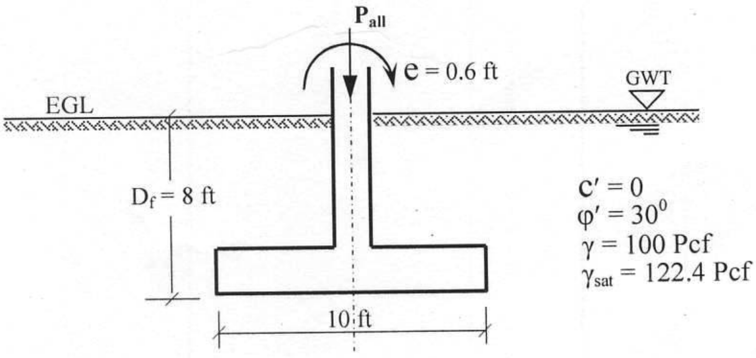


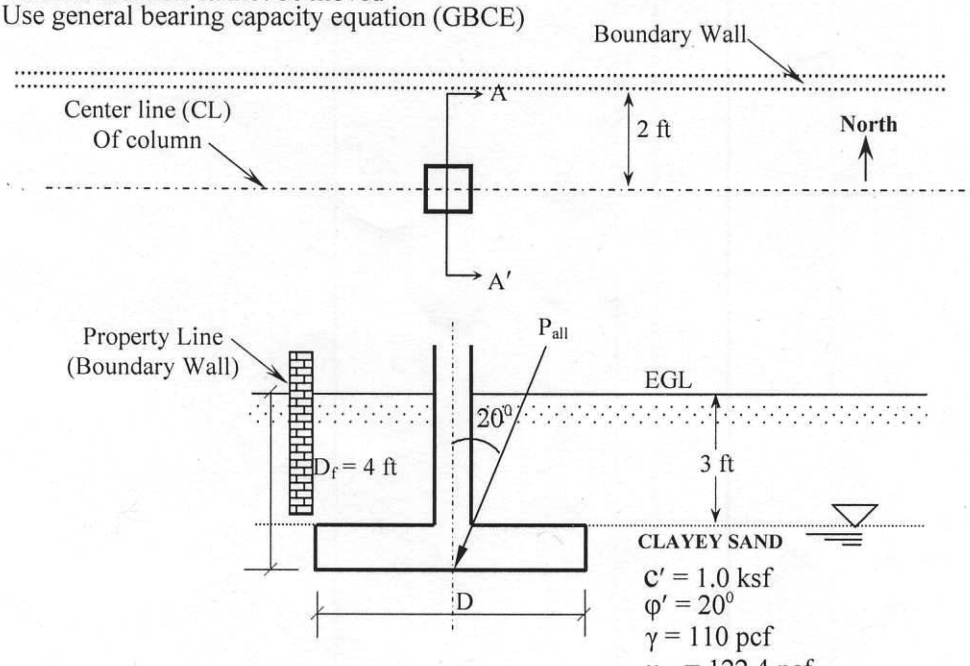
FIGURE (B)

(**b**) An eccentrically loaded continuous foundation is shown below. Determine the allowable load per unit length that the foundation can carry. Use Meyerhof's effective area method. Use FS = 2.5. 10



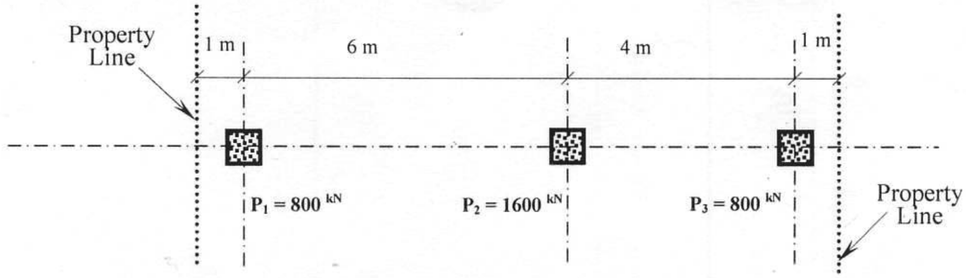
4. (**a**) For the following given conditions, determine the allowable column load (P_{all}) for the following footing. Factor of safety = 2.5 12

- Foundation spread cannot go beyond the interior of the boundary wall
- Circular footing
- Column location cannot be moved
- Use general bearing capacity equation (GBCE)

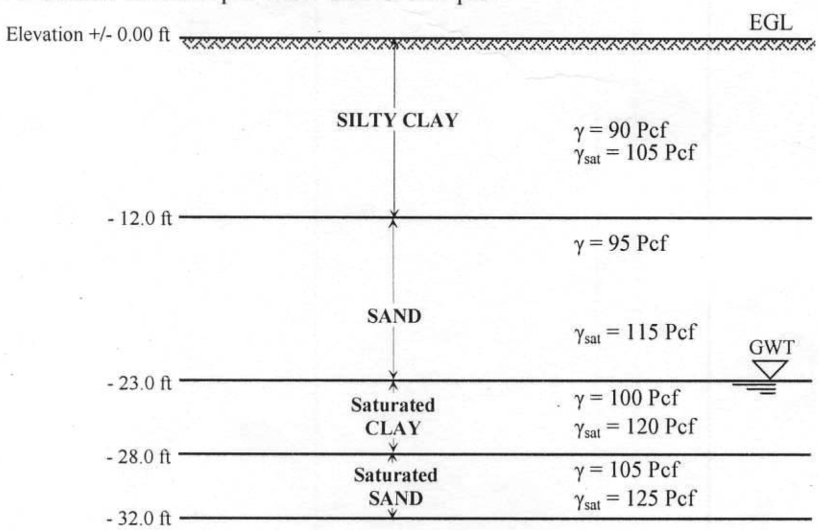


SEC A-A′

(**b**) Design the size of a trapezoidal combined footing for the loading, geometric and boundary conditions as shown in the figure below. Use allowable bearing capacity as 125 kN/m^2. 8

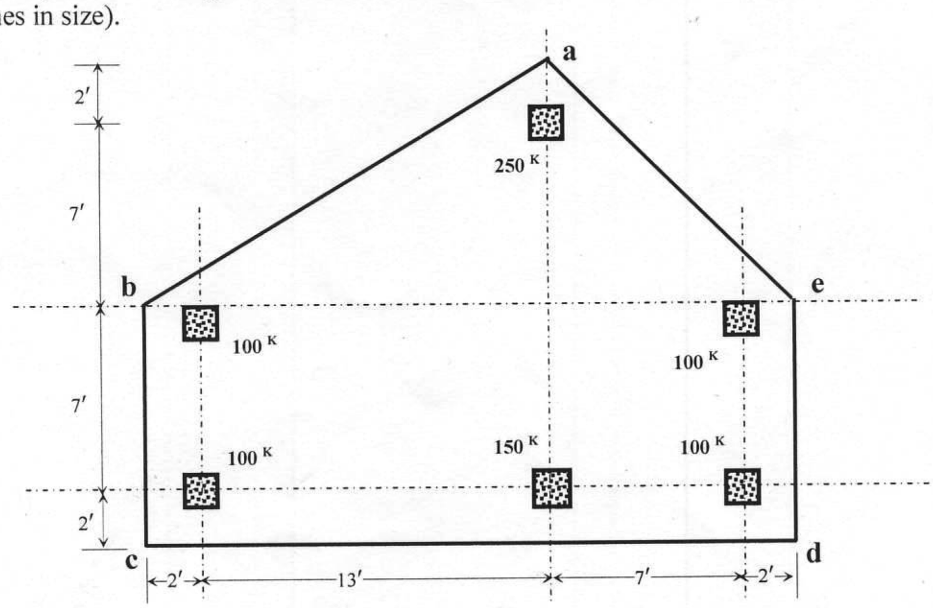


5. (**a**) For a fully compensated condition (floating foundation), if the depth of the mat foundation is selected to be 25 ft. below EGL, determine the number of stories that could be built. Consider uniform per floor load of 250 psf. 6



Subsurface Soil Stratigraphy

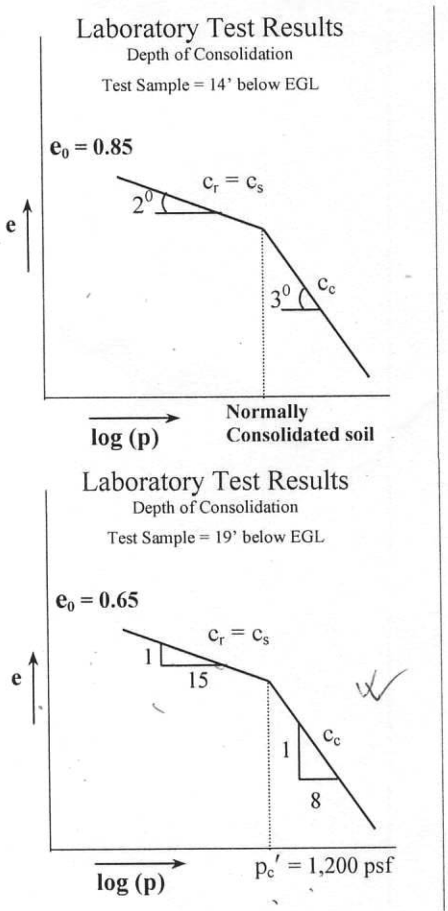
(**b**) The plan of a mat foundation is shown in the figure below. Calculate the soil pressures at points a, c and at the geometric centroid of the foundation (all the columns are of 15 by 15 inches in size). 14

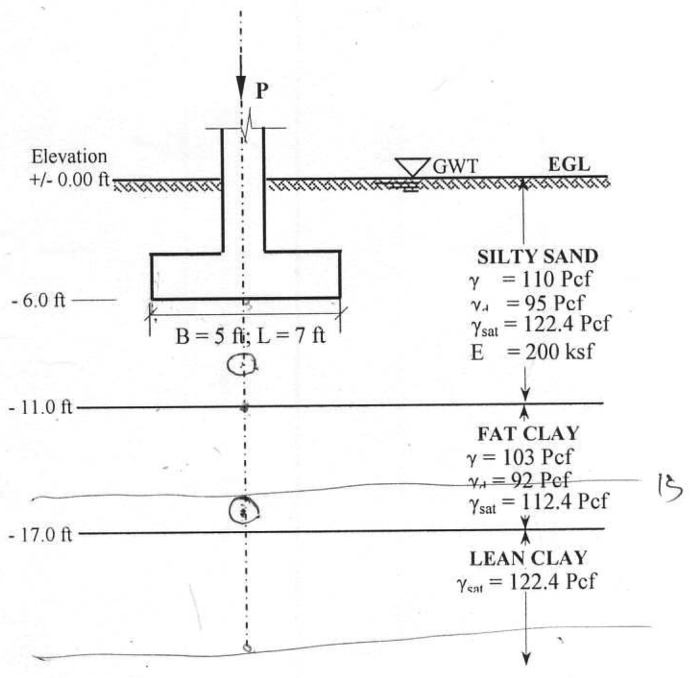


6. (**a**) Show with sketches different types of shear failures in soils of different strength. 3

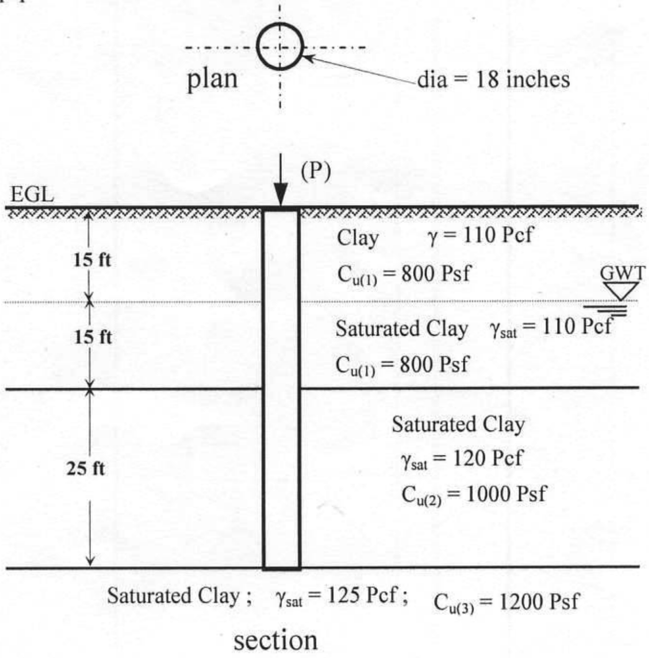
(**b**) Categorize (mention names only) combined footings with sketches. 3

(**c**) A rectangular footing designed as per allowable bearing capacity based on shear failure is shown in the following figure. Estimate settlements for both sand and clay layers. Use p = 3.0 ksf . Consider increased induced stress (applied stress) up to a depth of 3B below the foundation level. 14

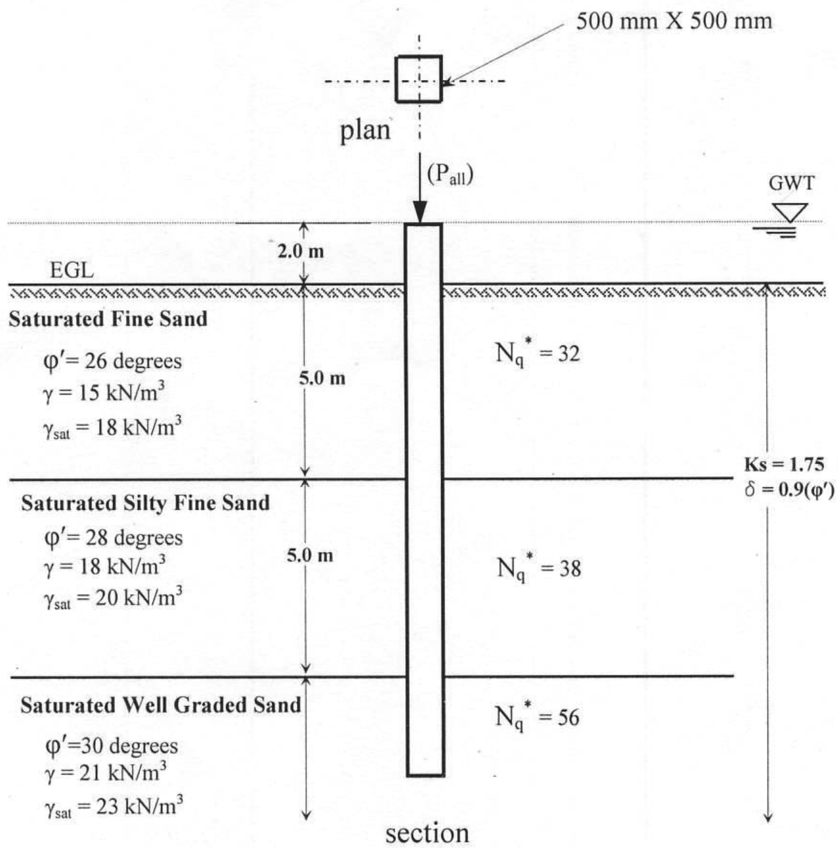




7. (a) For the soil stratigraphy as shown below, a group of 9 bored piles (each having diameter of 18-inches) were installed as per minimum center-to-center distance required. Calculate the capacity of the group pile. 10



(b) The plan and X-section of a 15-meter long single pre-cast concrete pile (square) driven in different sand deposits are shown below. Estimate the allowable capacity of the single pile. 10



8. (**a**) Classify pile foundations (mention names only) according to their materials (composition), method of installation and displacement criteria. 6

(**b**) Determine the factor of safety (stability) against the failure arcs through the slope for the slope as shown below. 14

LAYER I:
Sandy Clay
Average SPT Blow Count, N = 6
Unit Weight = 110 pcf

LAYER II:
Clay
Average SPT Blow Count, N = 12
Unit Weight = 115 pcf

LAYER III:
Clay
Average SPT Blow Count, N = 16
Unit Weight = 120 pcf

Segment No.	Area (ft^2)	Arm (ft)
1	10.8	---
2	31.2	---
3	---	7.8
4	15	---
5	---	13.2
6	---	---
7	---	---
8	---	---

--- to be calculated