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) Write down any three general guidelines used for (i) selection of spacing/numbers of boreholes (ii) selection of depth of boreholes for different civil engineering projects.   6

   (b) Write down the names of any four boring/drilling techniques generally used for sub-surface exploration. Write a very short note on the one frequently used in Bangladesh.   6

   (c) Write short notes on (any two):   4 x 2=8

   (i) Pressuremeter Test   (ii) Cone Penetrometer Test   (iii) Vane Shear Test

2. (a) The outside and inside diameters of a split-spoon sampler are 2 inches and 1.4 inches, respectively and those of a Shelby tube sampler are 3 inches and 2.85 inches, 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) Discuss, in brief, disturbed and undisturbed sampling.   6

   (c) Subsurface stratigraphy as obtained at a site for **BH-1** and **BH-2** are summarized in the figure below. Determine the field SPT values and estimate the corrected SPT values as required for both boreholes. Also determine undrained cohesion and angle of internal friction for clay and sand.   10
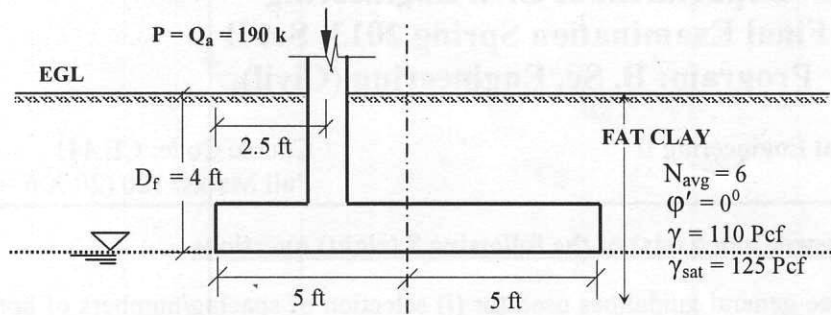

Subsurface Soil Stratigraphy
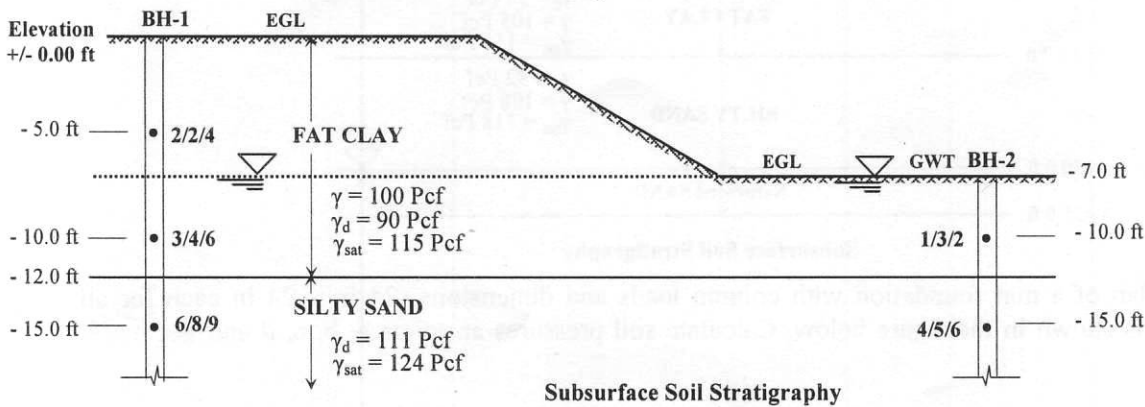
3. (a) A shallow circular foundation is to be constructed in sandy clay soil as shown in the following figure. Design the size of the circular footing (use GBCE) for the allowable column load (D ranges between 3 and 6 feet). Use a factor of safety of 2.5 and assume Df/B < 1).   10
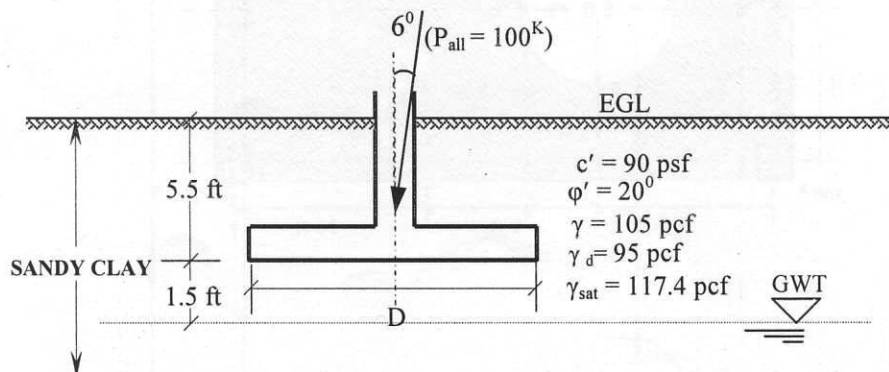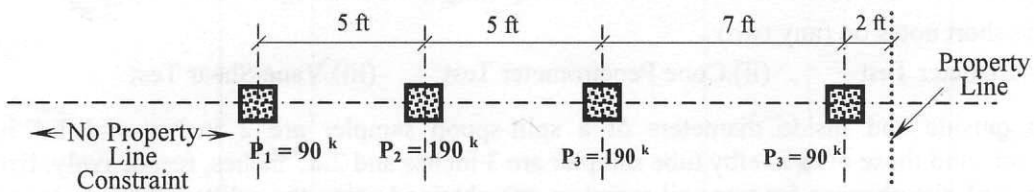
(b) Allowable load (FS=2.5) of an eccentrically loaded rectangular footing (Breadth as shown below) using Meyerhof's effective area method is 190 k. Determine the length of the footing.

10

$$P = Q_a = 190 \text{ k}$$

EGL

2.5 ft

$D_f = 4$ ft

FAT CLAY

$N_{avg} = 6$

$\varphi' = 0^0$

$\gamma = 110$ Pcf

$\gamma_{sat} = 125$ Pcf

5 ft   5 ft

4. **(a)** Design the size of a rectangular combined footing for the conditions shown below ($q_a = 2.0$ tsf).

3

5 ft   5 ft   7 ft   2 ft

Property Line

← No Property →
Line
Constraint

$P_1 = 90$ k $P_2 = 190$ k $P_3 = 190$ k $P_3 = 90$ k

(b) For fully compensated condition, if the depth of a mat foundation is 25 ft below EGL, determine the number of stories that could be built considering uniform per floor load as 200 psf.

3

EGL

Dry   SILTY CLAY

$\gamma_d = 90$ Pcf
$\gamma = 100$ Pcf
$\gamma_{sat} = 110$ Pcf

- 10.0 ft

FAT CLAY

$\gamma_d = 95$ Pcf
$\gamma = 105$ Pcf
$\gamma_{sat} = 115$ Pcf

- 18.0 ft

SILTY SAND

$\gamma_d = 92$ Pcf
$\gamma = 108$ Pcf
$\gamma_{sat} = 118$ Pcf

GWT

- 30.0 ft

Saturated SAND

- 35.0 ft

Subsurface Soil Stratigraphy
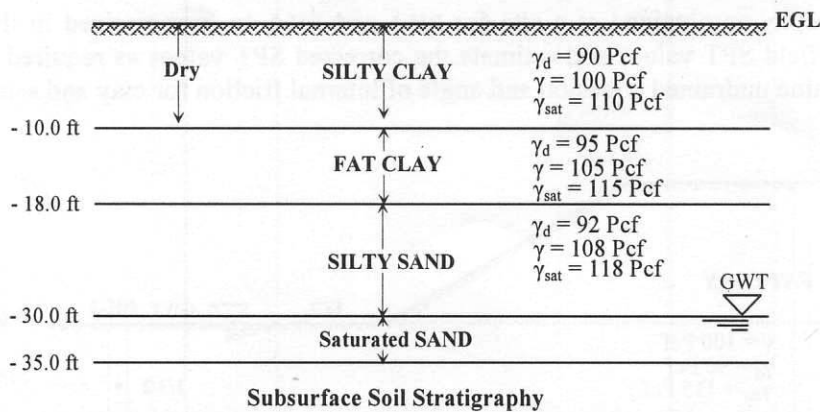
(c) The plan of a mat foundation with column loads and dimensions (24 in x 24 in each for all columns) is shown in the figure below. Calculate soil pressures at points a, b, c, d and geometric centroid.

14

200 K   300 K

4 ft

c

a   100 K

8 ft

9 ft

b

d

300 K   300 K

9 ft   9 ft   10 ft
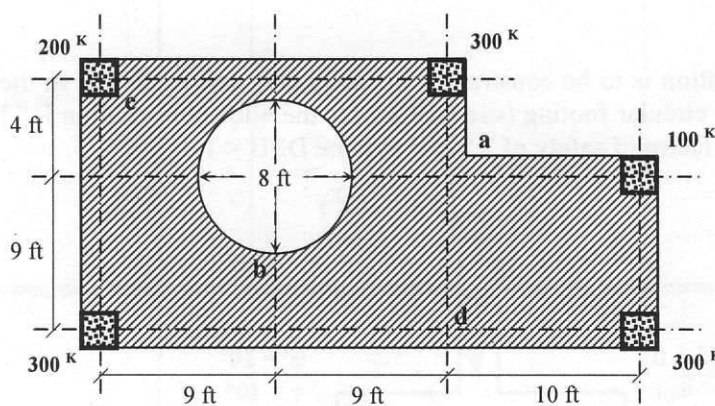
5. (a) Classify (mention names only) foundation systems generally used to support superstructures. **4**

(b) What do you understand by shallow and deep foundations? **2**

(c) A rectangular footing (4 ft x 6 ft) designed as per allowable bearing capacity based on shearing failure is shown in the following figure. Estimate settlements for both sand and clay layers. **14**

Laboratory Test Results

Depth of Consolidation
Test Sample = 10' below EGL

$e_0 = 0.69$

$c_r = c_s$

$\dfrac{1}{14}$

e

c_c

$\dfrac{1}{12}$

$\log (p)$

$p_c' = 1150$ psf

Elevation
+/- 0.00 ft

$P = 145^K$

EGL

SAND
$\gamma = 95$ Pcf
$\gamma_d = 92$ Pcf
$\gamma_{sat} = 107.4$ Pcf
$E = 90$ ksf

- 4.0 ft

$B = 4$ ft

GWT

SILTY SAND
$\gamma = 1150$ Pcf
$\gamma_d = 95$ Pcf
$\gamma_{sat} = 122.4$ Pcf
$E = 240$ ksf

- 6.0 ft

- 8.0 ft

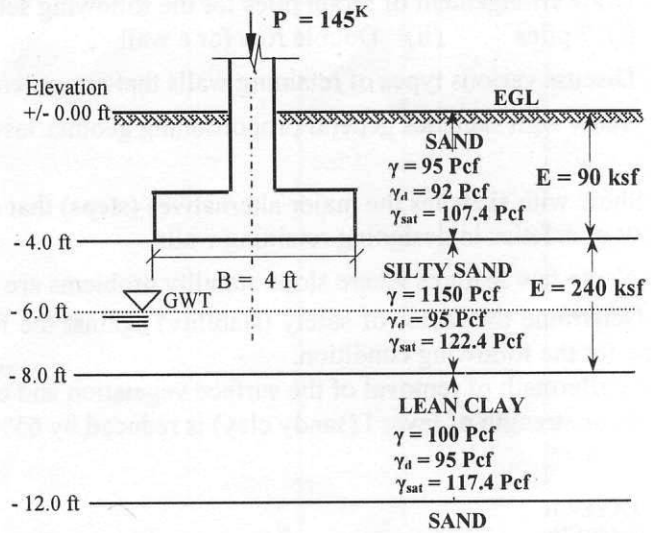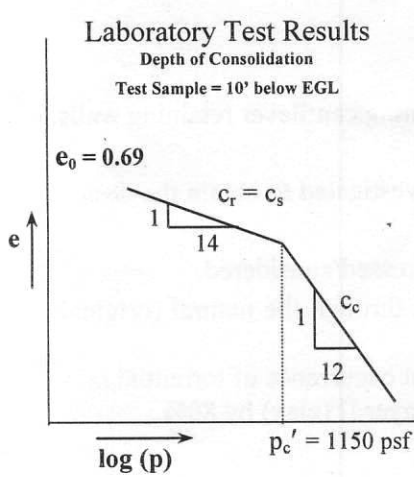**LEAN CLAY**
$\gamma = 100$ Pcf
$\gamma_d = 95$ Pcf
$\gamma_{sat} = 117.4$ Pcf

- 12.0 ft

SAND

6. (a) For the soil stratigraphy as shown below, a pre-cast concrete driven pile (0.5 by 0.5 meter) was installed. Calculate the capacity of the individual pile. **8**

(P)

EGL

6 m — Clay $N_{60(1)} = 4$ — GWT

6 m — Saturated Clay $N_{60(2)} = 2$

12 m — Saturated Clay $N_{60(2)} = 5$

Saturated Clay ; $N_{60(3)} = 6$
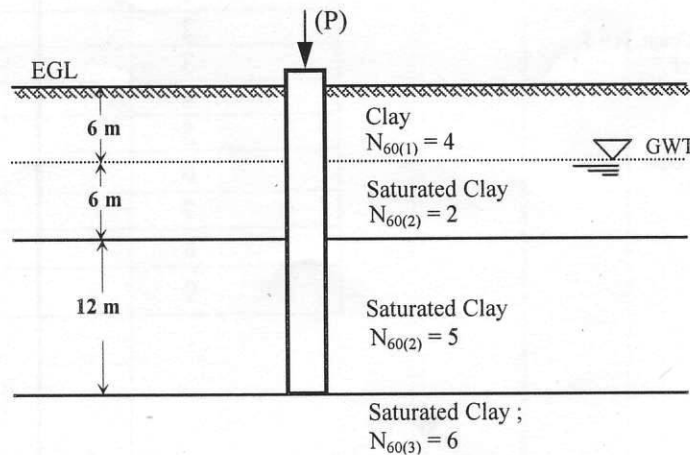
(b) A 10-meter long single bored pile (circular: Dia = 0.8 m) installed in different sand deposits are shown below. Estimate the allowable capacity of the single pile. (Nq* = 25 for φ'= 28 degrees; Nq* = 32 for φ'= 30 degrees; Nq* = 52 for φ'= 33 degrees) **12**

(P)

EGL

Saturated Fine Sand — 4.0 m
$\varphi' = 28$ degrees
$\gamma = 16$ kN/m³
2.0 m — GWT
$\gamma_{dry} = 15$ kN/m³
$\gamma_{sat} = 23$ kN/m³

Saturated Silty Fine Sand — 4.0 m
$\varphi' = 30$ degrees
$\gamma = 19$ kN/m³
$\gamma_{dry} = 17$ kN/m³
$\gamma_{sat} = 23$ kN/m³

Saturated Well Graded Sand
$\varphi' = 33$ degrees
$\gamma_{dry} = 18$ kN/m³
$\gamma = 21$ kN/m³
$\gamma_{sat} = 25$ kN/m³

7. **(a)** Classify (mention names only) pile foundations according to their materials (composition), method of installation and displacement criteria.   4

     (b) Draw arrangement of group piles for the following sets of piles.   4
         (i) 7 piles   (ii) Double row for a wall

     (c) Discuss various types of retaining walls that are generally used.   8

     (d) Show with sketches general proportioning geometries for designing cantilever retaining walls.   4

8. **(a)** Show with sketches the major alternatives (steps) that can be investigated to obtain the desired factor of safeties in designing retaining walls.   5

     (b) Name few features where slope stability problems are to be addressed/considered.   3

     (c) Determine the factor of safety (stability) against the failure arc through the natural (original) slope for the following condition: 12
As an aftermath of removal of the surface vegetation and consequent occurrence of torrential rain, the shear strength of layer I (sandy clay) is reduced by 65% and of layer II (clay) by 80%.

LAYER I:
Sandy Clay
Average SPT Blow Count, N = 4
Unit Weight = 110 pcf

LAYER II:
Clay
Average SPT Blow Count, N = 5
Unit Weight = 115 pcf

LAYER III:
Clay
Average SPT Blow Count, N = 8
Unit Weight = 120 pcf

Segment No.	Area (ft^2)	Arm (ft)
1	---	---
2	---	---
3	---	---
4	---	---
5	---	---
6	---	---
7	---	---
8	---	---
9	---	0

--- to be calculated