ELIZADE UNIVERSITY, ILARA-MOKIN
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
CVE 306 : SOIL MECHANICS
EXAMINATION FOR SECOND SEMESTER 2018/2019 SESSION

Instructions: Answer **Three questions** in all, **Question 3 is compulsory**. Use the Tables supply in the Appendix A where necessary.

Time Allowed: 3 Hrs **3 units**

Question 1 - (20 marks)

a) Explain the following processes of soil formation briefly. You are free to support your answer with diagram(s) where necessary;

i. Accumulation of materials
ii. Leaching losses and illuviation
iii. Transformation
iv. Podsolisation and translocation **(8 marks)**

b) Mention five (5) factors that affect soil formation. Distinguish between mechanical and chemical disintegration of rock in soil formation. **(4 marks)**

c) Differentiate between the following terms of soil formation;

i. Denudation and Deposition
ii. Colluvial and Glacial
iii. Hydration and carbonation
iv. Oxidation and reduction **(8 marks)**

Question 2- (20 marks)

a) Soils, as they exist in nature, consist of solid particles (mineral grains, rock fragments) with water and air in the voids between the particles. Explain with the aid of a schematic diagram or diagrams the three-phase system in terms of weight and volume. **(3 marks)**

b) i. A soil sample has a unit weight of 16.97kN/m^3 and a void ratio of 0.84. The specific gravity of solid is 2.7. Determine the moisture contents, dry unit weight and degree of saturation of the sample. **(6 marks)**

ii. An undisturbed sample of soil has a volume of 29 cm^3 and weighs 48 g. The dry weight of the sample is 32 g. The value of Gs = 2.66. Determine the
(a) natural water content,
(b) insitu void ratio,
(c) degree of saturation, and
(d) saturated unit weight of the soil. **(6 marks)**

c) A core cutter cylinder with internal diameter of 100mm and length of 125mm was used to collect soil sample from the site, the following data were obtained;

Mass of soil + cylinder = 3813g
Mass of empty cylinder = 1625g

Mass of dry soil = 1833g
Gs =2.71
Determine (i) the bulk and the dry densities, (ii) water content, (iii) void ratio and air-voids content **(5 marks)**

Question 3 - (20 marks)

a) Explain briefly what you understand as particle size distribution of a soil? State two methods you can use to measure the distribution of particle sizes in a soil sample? Explain sieve analysis in detail. **(8 marks)**

b) From the results of a sieve analysis, shown in Table Q3, determine: (a) the percent finer than each sieve and plot a grain-size distribution curve, (b) D_{10}, D_{30}, D_{60} from the grain-size distribution curve, (c) the uniformity coefficient, C_u, and (d) the coefficient of gradation, C_c. **(12 marks)**

Table Q4: Particle size analysis

Sieve Number	Diameter (mm)	Mass of soil retained on each sieve (g)
4	4.750	28
10	2.000	42
20	0.850	48
40	0.425	128
60	0.250	221
100	0.150	86
200	0.075	40
Pan	--	24

Question 4- (20 marks)

a) Explain briefly what you understand as Atterberg limits. How can you determine plastic limit of soil in the laboratory? **(8 marks)**

b) The laboratory test on a soil sample gave the following results;
W_n=24%, W_l =62%, W_p =28%, percentage of particle less than 2μ is 23%. Using the above results and the tables below, determine;
   i. Liquidity index
   ii. Activity
   iii. Consistency, nature of soil and its classification **(6 marks)**

c) A soil with a liquidity index of -20 has a liquid limit of 56% and a plasticity index of 20%.What is its natural content? What is the nature of the soil? **(6 marks)**

Question 5- (20 marks)

a) The sieve analysis of a given sample of soil gave 57% percent of the particles passing through 75 micron sieve. The liquid and plastic limits of the soil were 62 and 28 percent respectively. Classify the soil per AASTO and the Unified Soil Classification Systems. **(8 marks)**

b) For a large project, a soil investigation was carried out. Grain size analysis carried out on the samples gave the following average test results (Table Q5).

Table Q5: Grain size analysis

Sieve No.	Percentage finer
4	96
10	60
20	18
40	12
60	7
100	4
200	2

Classify the soil by using the Unified Soil Classification System assuming the soil is non-plastic. **(6 marks)**

c) Soil samples collected from the field gave the following laboratory test results:

Percentage passing No. 4 sieve	100
Percentage passing No. 200 sieve	76
Liquid limit	65
Plastic Limit	30

Classify the soil using the Unified soil classification System. **(6 marks)**

Appendix A: **Necessary and useful Tables**

Unified Classification System Table

Major divisions			Group symbol	Typical names	Classification criteria for coarse-grained soils	
Coarse-grained soils (more than half of material is larger than No. 200)	Gravels (more than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u \geq 4$ $1 \leq C_c \leq 3$	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW ($C_u < 4$ or $1 > C_c > 3$)	
		Gravels with fines (appreciable amounts of fines)	GM (d or u)	Silty gravels, gravel-sand-silt mixture	Atterberg limits below A line or $I_p < 4$	Above A line with $4 < I_p < 7$ are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixture	Atterberg limits above A line with $I_p > 7$	
	Sands (more than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_u \geq 6$ $1 \leq C_c \leq 3$	
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW ($C_u < 6$ or $1 > C_c > 3$)	
		Sands with fines (appreciable amount of fines)	SM (d or u)	Silty sands, sand-silt mixture	Atterberg limits below A line or $I_p < 4$	Above A line with $4 \leq I_p \leq 7$ are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-silt mixture	Atterberg limits above A line with $I_p > 7$	
Fine-grained soils (more than half of material is smaller than No. 200)	Silts and clays (liquid limit < 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	1. Determine percentages of sand and gravel from grain-size curve. 2. Depending on percentages of fines (fraction smaller than 200 sieve size), coarse-grained soils are classified as follows: Less than 5%–GW, GP, SW, SP More than 12%–GM, GC, SM, SC 5 to 12%–Borderline cases requiring dual symbols	
			CL	Inorganic clays of very low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			OL	Organic silts and organic silty clays of low plasticity		
	Silts and clays (liquid limit > 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			CH	Inorganic clays of high plasticity, fat clays		
			OH	Organic clays of medium to high plasticity, organic silts		
	Highly organic soils		Pt	Peat and other highly organic soils		

$$C_u = \frac{D_{60}}{D_{10}}$$

$$C_c = \frac{D_{30}^2}{D_{10} D_{60}}$$

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