B. Sc. Engg. (CEE)/ 4th Sem. 15 February 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Mid Semester Examination
Course No.: CEE 4441
Course Title: Soil Mechanics

Summer Semester: 2021-2022
Full Marks: 100
Time: 1.5 Hours

There are 4 (Four) questions. Answer 3 (Three) questions. Question 4 is compulsory. Answer 2 questions from question 1, 2 and 3. Programmable calculators are not allowed. The figures in the right margin indicate full marks. The Symbols have their usual meaning.

1(a). Briefly describe the classifications of water and glacier transported soils. (8) (CO1) (PO1)

1(b). **Table 1** shows the results of sieve and hydrometer analyses of soils collected from two probable locations (locations A and B) for constructing a 5-story building. Answer the followings for both locations- (24) (CO1) (PO1)

(i) Plot grain-size distribution curves.

(ii) Determine the group symbols and group names according to the Unified Soil Classification System for both soils. Soil A is non-plastic, Soil B: Liquid Limit is 42, and Plastic Limit is 20. (Use **Table A**).

(iii) Which site is suitable for a footing foundation system of the building based on the plasticity of the soil? Explain briefly.

Table 1. Results of sieve and hydrometer analyses

Sieve No.	Size (mm)	Mass retained on each sieve (g)	
		Soil A	Soil B
#4	4.75	0	0
#6	3.35	10	2
#10	2.00	25	10
#20	0.85	60	25
#40	0.425	80	20
#60	0.25	120	50
#100	0.15	125	65
#200	0.075	65	75
Hydrometer Test	0.06	15	70
	0.05	0	80
	0.04	0	30
	0.03	0	35
	0.02	0	38

2(a). Explain soil compaction and its benefits. Also, briefly explain Standard and Modified Proctor Compaction Tests and their suitability in different geotechnical structures. (8) (CO1) (PO1)

2(b). Draw total stress, pore water pressure, and effective stress distributions for the ground shown in **Fig.1** for - (i) immediately after applying the surcharge, and (ii) after complete dissipation of the excess pore water pressure. Use $\gamma_w = 9.81 kN/m^3$. (24) (CO1) (PO1)

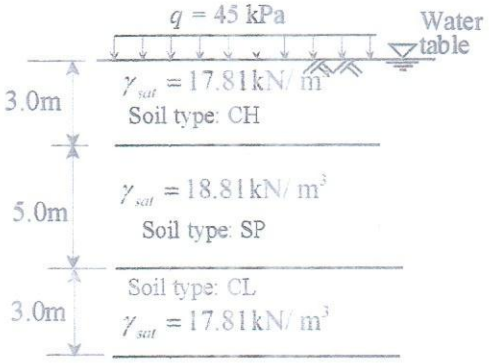

Fig.1 for Q.2(b)

3(a). Briefly explain the Consolidated Triaxial Drained (CD) and Consolidated Triaxial Undrained (CU) Tests including the corresponding graphs. (8) (CO1) (PO1)

3(b). Derive the relationship of major and minor principal stresses using the Mohr-Coulomb failure envelope of the direct shear test. (8) (CO1) (PO1)

3(c). The results of two CU tests are listed in **Table 2** for soil. Determine cohesion and angle of internal friction in effective stress condition. If a CD test is carried out at a confining pressure of 100 kPa, what will be the major principal stress at failure? (16) (CO1) (PO1)

Table 2. Results of CU tests

Test	Confining pressure (kPa)	At failure	
		Deviatoric stress (kPa)	Pore water pressure (kPa)
1	80	100	50
2	160	220	80

4(a). You are assigned to investigate the degree of compaction of the subgrade soil of a road construction, where the target degree of compaction is 95%. In the field results, the moisture content was 11.5%, and the moist density was 1700 kg/m^3 of the subgrade soil. Standard Proctor Compaction tests were carried out for the same soil, and the results are given in **Table 3**, where the volume of the container was 9.44^{-4} m^3. Write your decision based on the maximum dry density, optimum moisture content, and degree of compaction. (26) (CO3) (PO3)

Table 3. Standard Proctor test results

Mass of Wet soil in the mold (kg)	Moisture content (%)
1.55	9.30
1.60	10.50
1.64	11.70
1.68	14.30
1.67	15.50
1.65	16.20

4(b). The soil in Question 4(a) was brought from Matlab, and the properties of the soil are – $G_s = 2.68$, $w = 8\%$, and $e = 0.80$. How much water was required per cubic meter of compacted soil, and how much was the volume of the soil before compaction in one cubic meter?. (10) (CO3) (PO3)

Table A. Unified Soil Classification System for Q.1(b)

Criteria for assigning group symbols				Group symbol
Coarse-grained soils More than 50% of retained on No.200 sieve	Gravels More than 50% of coarse fraction retained on No.4 sieve	Clean gravels Less than 5% fines	$C_u \geq 4$ and $1 \leq C_c \leq 3$	GW
			$C_u < 4$ and/or $1 > C_c > 3$	GP
		Gravels with Fines More than 12% fines	$I_p < 4$ or plots below "A" line	GM
			$I_p > 7$ or plots on or above "A" line	GC
	Sands 50% or more of coarse fraction passes No.4 sieve	Clean sands Less than 5% fines	$C_u \geq 6$ and $1 \leq C_c \leq 3$	SW
			$C_u < 6$ and/or $1 > C_c > 3$	SP
		Sands with Fines More than 12% fines	$I_p < 4$ or plots below "A" line	SM
			$I_p > 7$ or plots on or above "A" line	SC
Fine-grained soils 50% or more passes No.200 sieve	**Silts and clays** Liquid limit less than 50	Inorganic	$I_p > 7$ or plots on or above "A" line	CL
			$I_p < 4$ or plots below "A" line	ML
		Organic	Liquid limit (oven dried) / Liquid limit (not dried)	OL
	Silts and Clays Liquid limit 50 or more	Inorganic	I_p plots on or above "A" line	CH
			I_p plots below "A" line	MH
		Organic	Liquid limit (oven dried) / Liquid limit (not dried)	OH
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			Pt

Gravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.
Sands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.