UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	GEOTECHNICS I
COURSE CODE	:	BFC 21702
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.** 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) An earth embankment is compacted at a water content of 18% to a bulk density of 19 kN/m^3. If the specific gravity of the sand is 2.65, determine the void ratio and degree of saturation of the compacted embankment.

(6 marks)

(b) Result of liquid limit test is shown in **Table 1** and the result of plastic limit is 13.4%.

(i) Examine the liquid limit of the soil.

(5 marks)

(ii) Calculate the plasticity index of the soil.

(2 marks)

(c) Figure **Q1(c)** depicts the particle size distribution for soils A and B.

(i) Determine the percentage of gravel, sand, silt and clay of soils A and B.

(8 marks)

(ii) Based on the percentage of soil particles and the result in **Q1(b)**, classify soil B using the AASHTO and USCS classification system. The classification system can be refered in **Appendix A**.

(4 marks)

Q2 (a) The soft soil sample is obtained from the Parit Raja area. Propose and justify the suitable method to determine the permeability of these soil.

(3 marks)

(b) Critically discuss the various parameters that affect the permeability of soil in the field.

(4 marks)

(c) The result of the laboratory compaction test is shown in **Table 2**. The specific gravity of the soil is 2.71.

(i) Determine the optimum moisture content and the maximum dry density of the soil using a suitable graph.

(6 marks)

(ii) Plot the zero-air void line.

(2 marks)

(iii) Predict the air content (%) at maximum dry density.

(3 marks)

(iv) Propose the range of moisture content to be used in the field compaction work.

(3 marks)

(v) The same soil was compacted in the field and the density of the soil obtained from sand cone replacement method is 1590 kg/m^3. Determine whether the compaction work is fulfilling the requirement by the department of public work Malaysia (JKR)?

(2 marks)

(vi) Proposed your recommendation if the compaction work does not fulfil the requirement.

(2 marks)

Q3 (a) Differentiate between total stress and effective stress.

(4 marks)

(b) A sediment settling lagoon has a depth of water of 2 m above the clay base. The clay layer is 3 m thick and this overlies 4 m of medium sand, which in turn overlies impermeable rock. Given that the unit weight of clay, medium sand and sediment of silty fine sand is 17.5 kN/m^3, 19.3 kN/m^3 and 16 kN/m^3, respectively. Produce the effective stress pressure diagram at the top of the clay and at the top and bottom of the second layer under the following condition:

(i) Initial, before any sediment is deposited.

(7 marks)

(ii) After a 1 m layer of sediment of silty fine sand has been deposited.

(7 marks)

(iii) After draining the lagoon down to base level, with the same thickness (2 m) of sediment still in place.

(7marks)

Q4 (a) Explain the principle of the direct shear test, the advantages of this test, and the limitations of the test.

(7 marks)

(b) A series of undrained shear box tests (area of box = 360 mm^2) were carried out on the soil with the results obtained in **Table 3**.

(i) Determine the cohesion, c (kN/m^2) and angle of friction, ϕ (°) of the soil with respect to total stress.

(8 marks)

(ii) If a 38 mm diameter, 76 mm long sample of the same sample was tested in a triaxial machine, with a cell pressure of 270 kN/m^2 , predict the additional axial load (kN) at failure.

(5 marks)

(iii) If a further sample of the soil was tested in an unconfined compression apparatus, at what value of compressive stress would failure be expected?

(5 marks)

– END OF QUESTIONS –

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Appendix A: Design Tables and Charts

Table 1: Data of liquid limit test

Number of blow	Moisture content
15	43.1
18	37.5
22	35.1
31	25.0

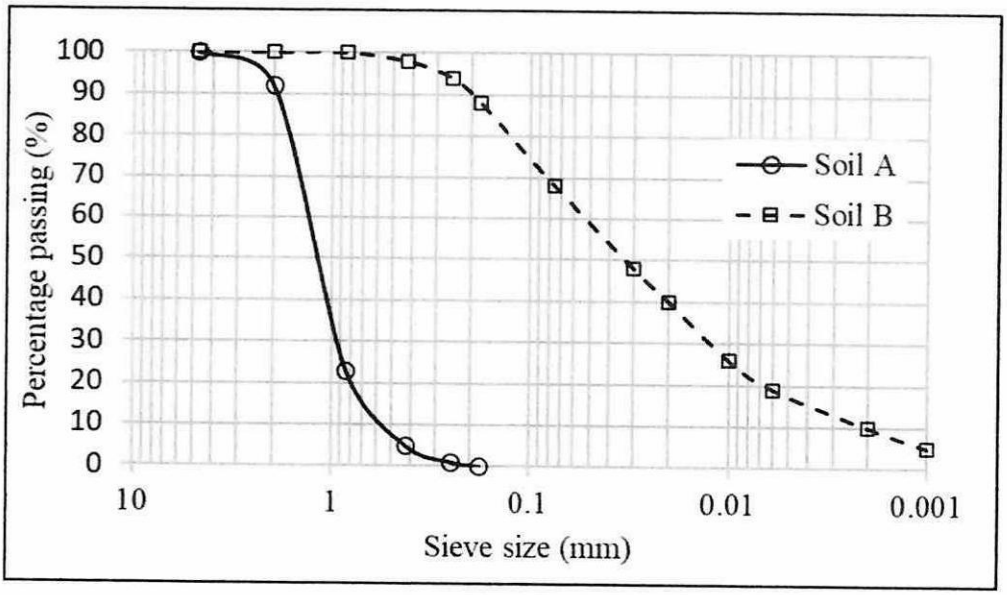

Figure Q1 (c): Particle size distribution of soil

Table 2: Compaction test result

Test no.	1	2	3	4	5
Moisture content, w	8	16	21	25	27
Bulk density, ρ_{bulk}	1634	1899	1989	1956	1932

Table 3: Data of direct shear test

Normal load (N)	Shear force at failure (N)
90	70
180	90
270	117

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Appendix A: Design Tables and Charts

AASHTO soil classification system

General classification	Granular materials (35% or less of total sample passing No. 200)						
	A-1			A-2			
Group classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7
Sieve analysis (percent passing)							
No. 10	50 max.						
No. 40	30 max.	50 max.	51 min.				
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.
Characteristics of fraction passing No. 40							
Liquid limit				40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	10 max.	10 max.	11 min.	11 min.
Usual types of significant constituent materials	Stone fragments, gravel, and sand		Fine sand	Silty or clayey gravel and sand			
General subgrade rating	Excellent to good						

General classification	Silt-clay materials (more than 35% of total sample passing No. 200)			
Group classification	A-4	A-5	A-6	A-7 A-7-5* A-7-6†
Sieve analysis (percent passing)				
No. 10				
No. 40				
No. 200	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40				
Liquid limit	40 max.	41 min.	40 max.	41 min.
Plasticity index	10 max.	10 max.	11 min.	11 min.
Usual types of significant constituent materials	Silty soils		Clayey soils	
General subgrade rating	Fair to poor			

*For A-7-5, $PI \leq LL - 30$
†For A-7-6, $PI > LL - 30$

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Appendix A: Design Tables and Charts

USCS soil classification system

Table 4.2 Unified Soil Classification System (Based on Material Passing 75-mm Sieve)

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[a]	$C_u \geq 4$ and $1 \leq C_c \leq 3^c$	GW
			$C_u < 4$ and/or $1 > C_c > 3^c$	GP
		Gravels with Fines More than 12% fines[a,d]	$PI < 4$ or plots below "A" line (Figure 4.2)	GM
			$PI > 7$ and plots on or above "A" line (Figure 4.2)	GC
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[b]	$C_u \geq 6$ and $1 \leq C_c \leq 3^c$	SW
			$C_u < 6$ and/or $1 > C_c > 3^c$	SP
		Sands with Fines More than 12% fines[b,d]	$PI < 4$ or plots below "A" line (Figure 4.2)	SM
			$PI > 7$ and plots on or above "A" line (Figure 4.2)	SC
Fine-Grained Soils 50% or more passes No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above "A" line (Figure 4.2)[e]	CL
			$PI < 4$ or plots below "A" line (Figure 4.2)[e]	ML
		Organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit–not dried}} < 0.75$; see Figure 4.2; OL zone	OL
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line (Figure 4.2)	CH
			PI plots below "A" line (Figure 4.2)	MH
		Organic	$\frac{\text{Liquid limit–oven dried}}{\text{Liquid limit–not dried}} < 0.75$; see Figure 4.2; OH zone	OH
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			Pt

[a]Gravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.
[b]Sands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.
[c]$C_u = \frac{D_{60}}{D_{10}}$; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$
[d]If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol GC-GM or SC-SM.
[e]If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 4.2, use dual symbol CL-ML.

TERBUKA

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Appendix B: Formulas

These formula may be useful to you. The symbols have their usual meaning

$$G_s = \frac{\gamma_s}{\gamma_w} = \frac{\rho_s}{\rho_w}$$

$$\rho_d = \frac{\rho_b}{1+w}$$

$$\rho = \frac{G_s \rho_w}{1+\frac{wG_s}{S_r}}$$

$$S_r = \frac{wG_s}{\left(\frac{G_s \rho_w}{\rho} - 1\right)}$$

$$\text{Relative compaction}, R = \frac{\gamma_{d(\text{field})}}{\gamma_{d(\text{lab})}} \times 100$$

$$\tau_f = c + \sigma \tan \phi$$

$$\sigma_1 = \sigma_3 \tan^2(45 + \phi/2) + 2c \tan(45 + \phi/2)$$