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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME	:	GEOTECHNIC I
COURSE CODE	:	BFC21702
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2020
DURATION	:	4 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTION IN **PART A** AND **THREE (3)** QUESTIONS IN **PART B**

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THIS QUESTIONPAPER CONSISTS OF ELEVEN (11) PAGES

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PART A

Q1 (a) Elaborate ~~and explain~~ briefly the triaxial compression test for the determination of the shearing resistance of soils and explain the principles of **THREE (3)** types of test which are commonly conducted.

(5 marks)

(b) **Table 1** contains data obtained from consolidated undrained tests on soft clay. You need to determine the shear strength parameters in term of total stress and effective stress. A different specimen of the same soil is alsotested in undrained triaxial compression at a cell pressure of 150 kN/m^2, and fails when the deviator stress is 75 kN/m^2. Calculate the pore pressure in the specimen failure.In your opinion, what is the differences between total stress and effective stress?

(8 marks)

(c) As a geotechnical engineer, you have been given a task to determine the shear strength parameter for different field cases as below;

(i) The stability of a clay foundation on an embankment; the rate of construction being such that some consolidation of the clay occurs
(ii) The initial stability of footing on saturated clay
(iii) The long term stability of slope in stiff clay

You need to describe and justify the suitable type of laboratory for shear strength test for each case.

(12 marks)

PART B

Q2 (a) There are two soil classification systems that are commonly used for soil classification which are the United Soil Classification System (USCS) and American Association of State Highway and Transportation Officials (AASHTO) classification system.

Briefly explain any **TWO (2)** of the similarity and the differences between these **TWO (2)** classification systems.

(6 Marks)

(b) By referring to the particle size distribution curve, either the soil is well graded, gap-graded or uniformly graded can de identified.Describe with the aid of sketches the differences between of particle size distribution.

(4 marks)

(c) The results of a particle size analysis of a soil are given in **Table 2.**

(i) Plot the particle size distribution curve.

(5 marks)

(ii) Based on the particle size distribution curve, do explain your answer based on the Atterberg limit tests on this soil?

(6 marks)

(iii) Classify the type of soil according to the USCS standard which can be referred in **Figure Q2(c)**.

(4 marks)

Q3 (a) The mass of a moist soil sample having a void ratio, e of 0.62. The moisture content and the soil density of the soil solids were determined to be 15 % and 2.65 Mg/m^3 respectively. Calculate:

(i) Dry density

(2 marks)

(ii) Density

(2 marks)

(iii) Moisture content when degree of saturation, S = 100%

(2 marks)

(iv) Saturated density when degree of saturation, S = 100%

(1 mark)

(b) A soil contaminated with gasoline (specific gravity) as shown in **Figure Q3 (b)** with the following characteristics þs = 2.65 Mg/m3, moisture content, w = 25 %. Volume of gasoline is 20 % of the volume of the water and 85 % of the void space is filled with gasoline and water.

(i) Complete the phase diagram in **Figure Q3 (b)**

(10 marks)

(ii) Calculate the void ratio and porosity of the specimen

(4 marks)

(iii) Determine the density and dry density of the specimen

(4 marks)

Q4 (a) List **FOUR (4)** effect of improper compaction of soil in the field.

(4 marks)

(b) A soil sample from a proposed road construction in Segamat, Johor was sent to a Geotechnical Laboratory UTHM, for a compaction test. The results of compaction test obtained using modified Proctor compaction test is shown in **Figure Q4 (b)**.

(i) Predict the maximum dry density (ρ_{dmax}), optimum moisture content (OMC), the dry density at 95% compaction and the range of moisture content at 95% compaction on dry side and wet side.

(4 marks)

(ii) Calculate the degree of saturation (S_r) and void ratio (e) at the maximum dry unit weight point if the specific gravity is 2.65.

(4 marks)

(iii) The sand cone replacement method was performed by a contractor and the results is depicted in **Table 3**. Determine the bulk density (ρ_b) and dry density (ρ_{dry})of the soil, then calculate the relative compaction (RC).

(9 marks)

(iv) Does the compaction in the field meet the requirement by Public Work Department of Malaysia (JKR)? Justify your answer?

(2 marks)

(v) If the compaction does not meet the requirement, what should the contractor do to meet the requirement?

(2 marks)

Q5 (a) Soil have interconnected voids through which water can flow from points of high energy to point of low energy. It is necessary for estimating the quantity of underground seepage under various hydraulic conditions. Based on that statement;

(i) Calculate the discharge velocity of water.

(2 marks)

(ii) If discharge velocity of water through a soil is 24 cm/hr and soil porosity is 30%, determine the seepage velocity of the water.

(2 marks)

(iii) Compute the hydraulic conductivity of soil.

(2 marks)

(b) In a constant head permeability test in the laboratory as shown in **Figure Q5 (b)**,the following values are given as;

Length of specimens = 310 mm
Diameter of specimen = 150 mm
Head different = 450 mm
Water collected in 5 min = 400 cm^3

The void ratio of the soil specimen is 0.5

Determine the following;

(i) hydraulic conductivity, k, of the soil in m/sec.

(4 marks)

(ii) discharge velocity in m/sec.

(4 marks)

(iii) seepage velocity in m/sec.

(4 marks)

(c) A permeable soil layer in underlain by an impervious layer, as ahown in **Figure Q5(c).** With permeability (k) = 5.2 x 10^{-4} cm/sec for the permeable layer. Given H = 3.8 m and $\alpha = 8°$. Calculate the rate of seepage through it in m^3/hr/m length.

(7 marks)

Q6 (a) Explain in detail on the concept of effective stress in terms of soil particle forces.

(3 marks)

(b) A layer of saturated clay with 4 m thick is overlain by sand with thickness of 5 m deep, the water table being 3 m below the surface, as shown in **Figure Q6(b)**. The saturated unit weights of the clay and sand are 19 and 20 kN/m^3, respectively; above the water table the (dry) unit weight of the sand is 17 kN/m^3.

(i) Plot the diagrams of total vertical stress, pore water pressure and effective vertical stress against depth and

(6 marks)

(ii) calculate the total stress, pore water pressure, and effective stress at points A, B and C.

(6 marks)

(c) A trench needs to be constructed at a certain saturated clay underlain by a layer of sand as shown in **Figure Q6(c).** In order to maintain the stability of the saturated clay,

(i) Design the appropriate height of the cut for the trench.

(5 marks)

(ii) Based on the height of the cut determined from **Q6(c)(i)**, if water is present in the trench determine the height of the water that needs to be controlled so that the stability of the saturated clay is not lost.

(5 marks)

-END OF QUESTIONS-

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TABLE1 Result from consolidated undrained tests

Cell pressure during consolidation and shear (kN/m^2)	At failure	
	Deviator stress (kN/m^2)	Pore water pressure (kN/m^2)
200	117	110
400	242	227
800	468	455

TABLE 2 Result for sieve analysis

Sieve size (mm)	9.53	4.75	2.00	0.850	0.425	0.150	0.075
% finer	100	89.8	70.2	62.5	49.8	28.6	4.1

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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 $C_c < 1$ or $C_c > 3$[c]	GP
		Gravels with Fines More than 12% fines[a,d]	$PI < 4$ or plots below "A" line (Figure 5.3)	GM
			$PI > 7$ and plots on or above "A" line (Figure 5.3)	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 $C_c < 1$ or $C_c > 3$[c]	SP
		Sands with Fines More than 12% fines[b,d]	$PI < 4$ or plots below "A" line (Figure 5.3)	SM
			$PI > 7$ and plots on or above "A" line (Figure 5.3)	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 5.3)[e]	CL
			$PI < 4$ or plots below "A" line (Figure 5.3)[e]	ML
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$; see Figure 5.3; OL zone	OL
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line (Figure 5.3)	CH
			PI plots below "A" line (Figure 5.3)	MH
		Organic	$\frac{\text{Liquid limit—oven dried}}{\text{Liquid limit—not dried}} < 0.75$; see Figure 5.3; 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 5.3, use dual symbol GC-GM or SC-SM.

[e]If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 5.3, use dual symbol CL-ML.

FIGURE Q2(c)(ii)

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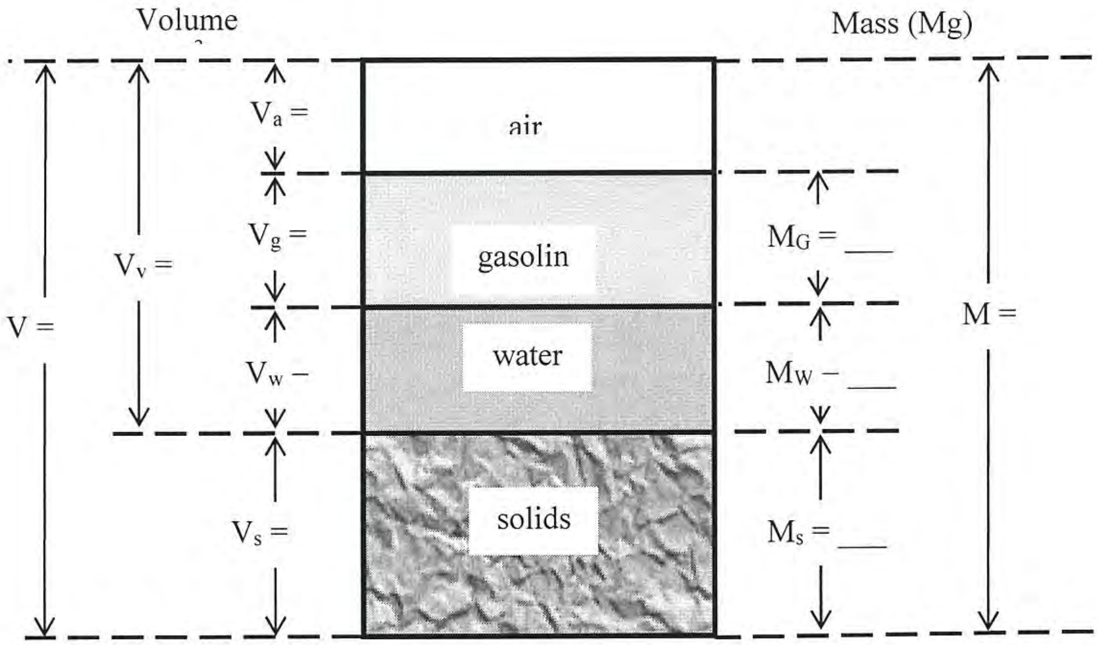

FIGURE Q3 (b) Soil element in natural state and three phase of the soil element.

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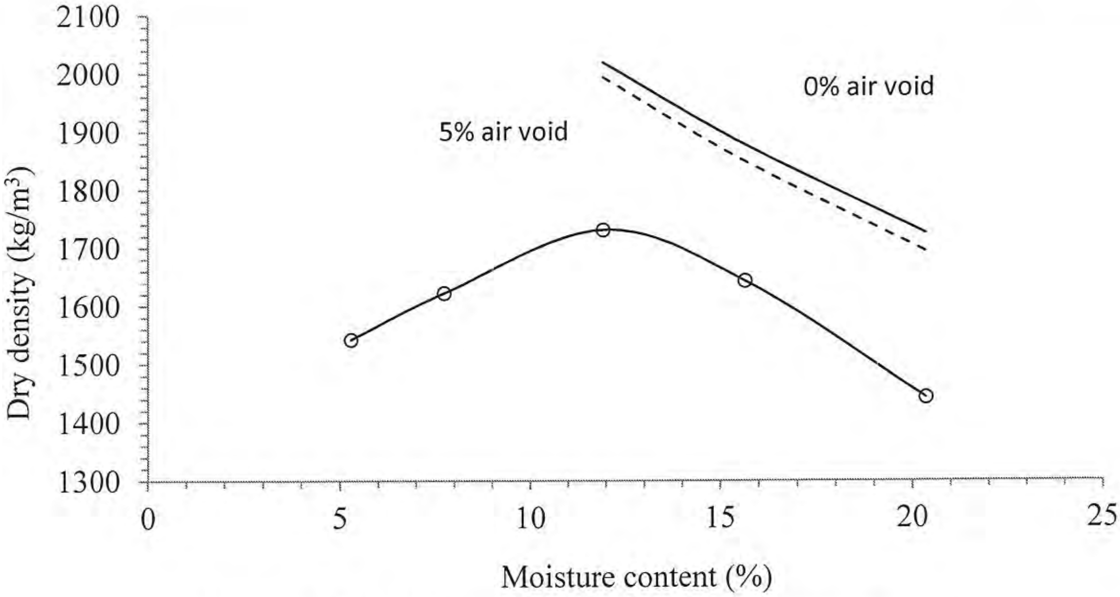

FIGURE Q4 (b) The compaction curve of Segamat soil

TABLE3 The results of sand cone replacement test

		Unit
Calibrated unit weight of sand	1451	kg/m^3
Calibrated volume of cone	1×10^{-3}	m^3
Weight of wet soil obtained from the hole	3.545	kg
Weight of sand to fill the hole and cone	4.645	kg
Weight of dry soil obtained from the hole	3.165	kg

Formula:

$$\gamma_d = \frac{G_s \rho_w}{1+e}$$

$$e = \frac{wG_s}{S_r}$$

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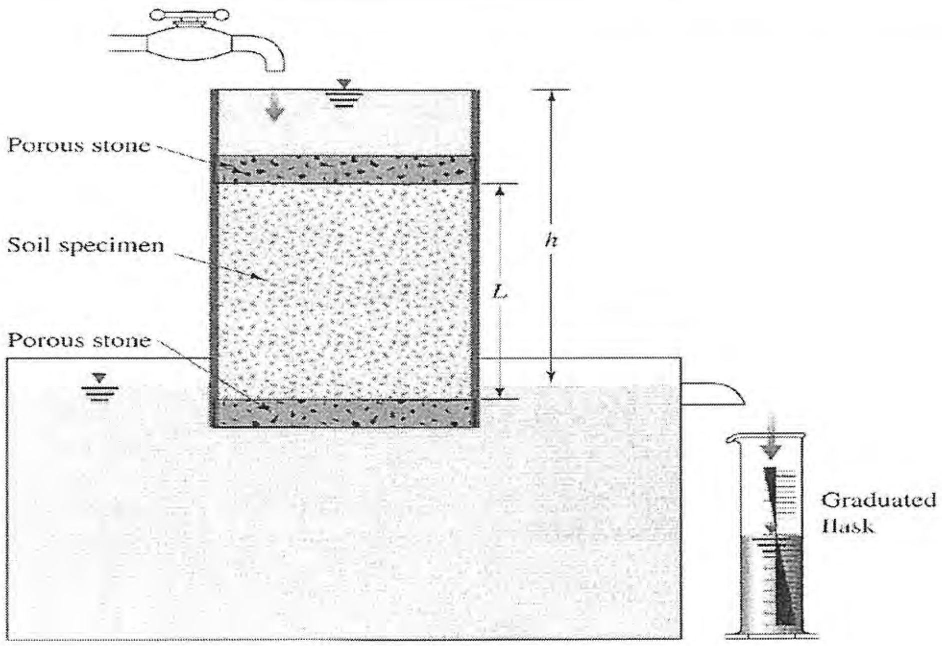

FIGURE Q5 (b): A constant head permeability test

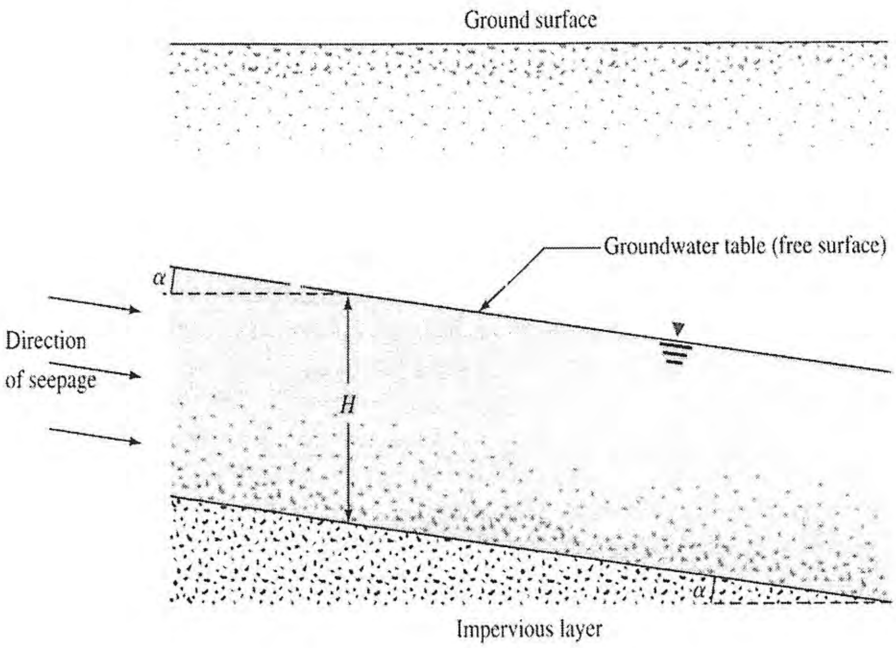

FIGURE Q5(c): A permeable soil layer

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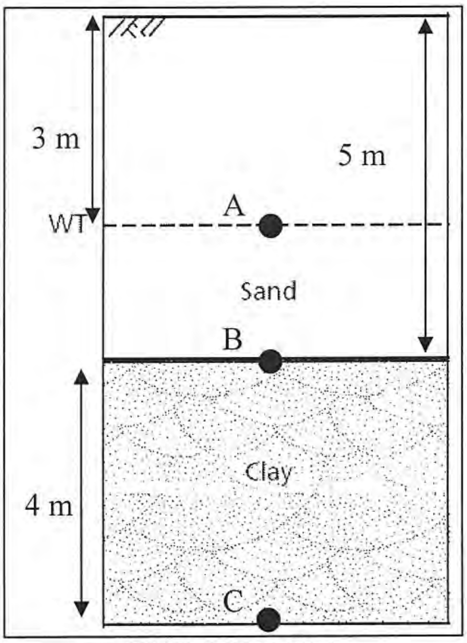

FIGURE Q6(b)

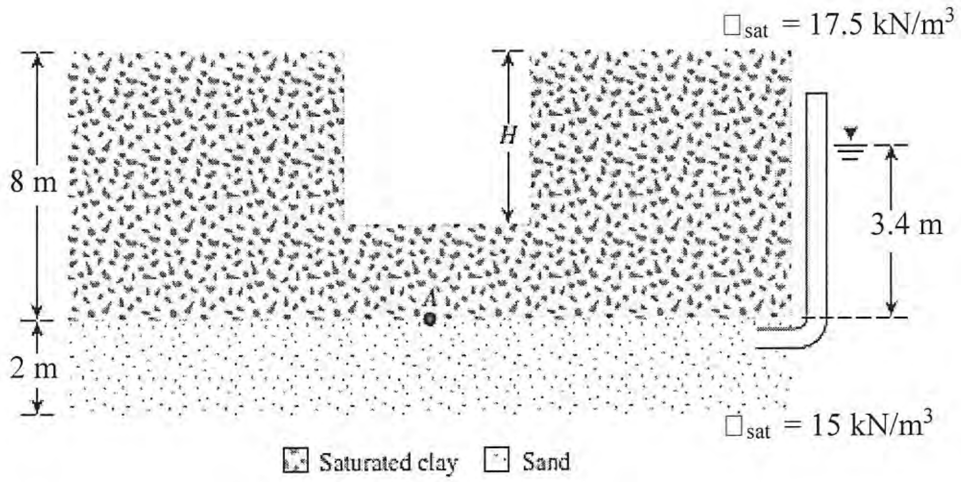

FIGURE Q6(c)