UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	GEOTECHNICS I
COURSE CODE	:	BFC 21702
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015 / JANUARY 2016
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN PART A AND ANY **TWO (2)** QUESTIONS FROM PART B

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

PART A

Q1 (a) One of the important parameters needed in designing a shallow foundation on soil at a given site is its shear strength parameters.

(i) Explain what shear strength parameters are.

(4 marks)

(ii) Briefly describe how these parameters are measured in a laboratory using a direct shear test method with the aid of sketches.

(6 marks)

(iii) Briefly explain how shear strength are measured in-situ using vane shear test method.

(6 marks)

(b) The results of three Consolidated-Undrained triaxial tests on identical soil specimens of a particular soil are listed in **TABLE Q1** below.:

TABLE Q1

Test No.	Confining pressure (kN/m^2)	Deviator stress at failure (kN/m^2)	Pore pressure at failure (kN/m^2)
1	200	244	55
2	300	314	107
3	400	384	159

(i) Determine the total and the effective shear strength parameters of the soil.

(10 marks)

(ii) What would be the expected deviator stress and the pore pressure at failure for a test with the confining pressure of 100 kPa.

(6 marks)

(iii) Comments on the usage of both the total and the effective shear strength parameters of the soil in designing geotechnical engineering structures.

(8 marks)

PART B

Q2 (a) Soil in nature is a three-phase system which consists of solid soil particles, and void containing water and air. Water has mass and weight while air is mass-less but it occupies part of the soil volume.

Based on that statement,

(i) What is a fully saturated soil?

(2 marks)

(ii) Define the porosity of soil.

(2 marks)

(b) Some representative soil specimen has been collected from a field embankment. The specific gravity and moist unit weight of the soil are determined as 2.67 and 17.61 kN/m^3 respectively in laboratory while moisture content is found to be 10.8 %.

Determine;

(i) Dry unit weight of soil

(2 marks)

(ii) Void ratio of soil

(2 marks)

(iii) Porosity

(2 marks)

(iv) Degree of saturation

(2 marks)

(v) If the degree of saturation of soil is required to be 80%, determine the weight of water (in kN) that need to be added per cubic meter of soil.

(4 marks)

(c) The particle size distribution of soil determined from sieve analysis is shown in **TABLE Q2**.

TABLE Q2: Sieve analysis results

Sieve size (mm)	Mass of soil retained on each sieve (g)
4.75	0.0
2.00	18.5
0.850	53.2
0.425	90.5
0.250	81.8
0.150	92.2
0.075	58.5
Pan	26.5

(i) Determine the percentage finer than each sieve size and plot a grain-size distribution curve.

(7 marks)

(ii) Determine D_{10}, D_{30} and D_{60} from the grain-size distribution curve.

(3 marks)

(iii) Calculate the uniformity coefficient, C_u.

(2 marks)

(iv) Calculate the coefficient of gradation, C_c.

(2 marks)

Q3 (a) "Compaction is the process of packing together the soil particles by reducing the air voids".

Explain with the aid of appropriate diagrams, how this process is influenced by;

(i) increasing the moisture content

(3 marks)

(ii) increasing the compaction energy

(3 marks)

(b) Laboratory observations from a standard Proctor compaction test carried out on a soil sample collected from a highway construction site is given in the **TABLE Q3** below. The volume and mass of the empty Proctor mould was 943 cm^3 and 2.4 kg respectively.

TABLE Q3: Standard Proctor compaction test results

Moisture content (%)	9.9	10.6	12.1	13.8	15.1	17.4	19.4	21.2
Mass of the mould and wet compacted soil (kg)	4.08	4.11	4.17	4.23	4.26	4.28	4.27	4.25

Determine the maximum dry unit weight (kN/m^3), moisture content and the air porosity of the optimum sample.

(15 marks)

(c) The earthwork requirements at the highway construction site specify a relative compaction of 92.5%. The field characteristics determined for a compacted soil sample from the construction site is 10.5% and 1700 kg/m^3 moisture content and moist density respectively.

Investigate and comment on the level of compaction at the construction site.

(9 marks)

Q4 (a) Briefly explain what is referred as boiling or quick condition and how this condition will happen.

(6 marks)

(b) Effective stress of saturated soil under seepage condition is found to be different from the conditon without seepage.

Please explain what is the effect of

(i) upward seepage

(ii) downward seepage

on the effective stress of saturated soil.

(6 marks)

(c) In a falling head permeability test on fine sand, the sample is 75 mm diameter and 150 mm length and the standpipe 10 mm diameter. A stopwatch is started when h = 500 mm and stopped when h = 250 mm and reads 19.6s. The test is repeated for a drop from 250 mm to 125 mm and the time is 19.4 s.

Determine the coefficient of permeability of fine sand in mm/s.

(8 marks)

(d) A pumping test was carried out to determine the coefficient of permeability of soil site which was selected for the construction of an earth dam. Observation wells were establish at a distance of 3 m and 6 m for the test well.

The following data were obtained :

Depth of water table	= 16 m
Discharge under steady condition	= 2.3m^3/min
Drawdown at outer well	= 0.50 m
Drawdown at inner well	= 1.5 m

Determine the coefficient of permeability of the soil in m/min.

(10 marks)

- END OF QUESTION -

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List of formula:

$$k = \frac{QL}{Aht} \; ;$$

$$k = 2.303 \frac{aL}{At} \log_{10} \frac{h_1}{h_2}$$

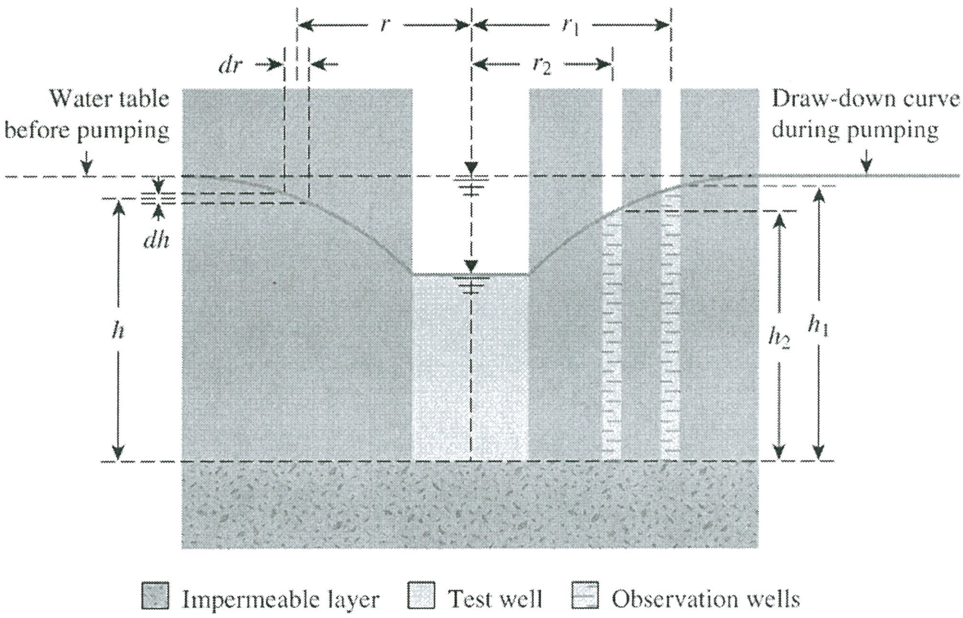

FIGURE A: Pumping test from a well in an unconfined permeable layer underlain by an impermeable stratum

$$k = \frac{2.303 q \log_{10}\left(\frac{r_1}{r_2}\right)}{\pi\left(h_1^2 - h_2^2\right)}$$

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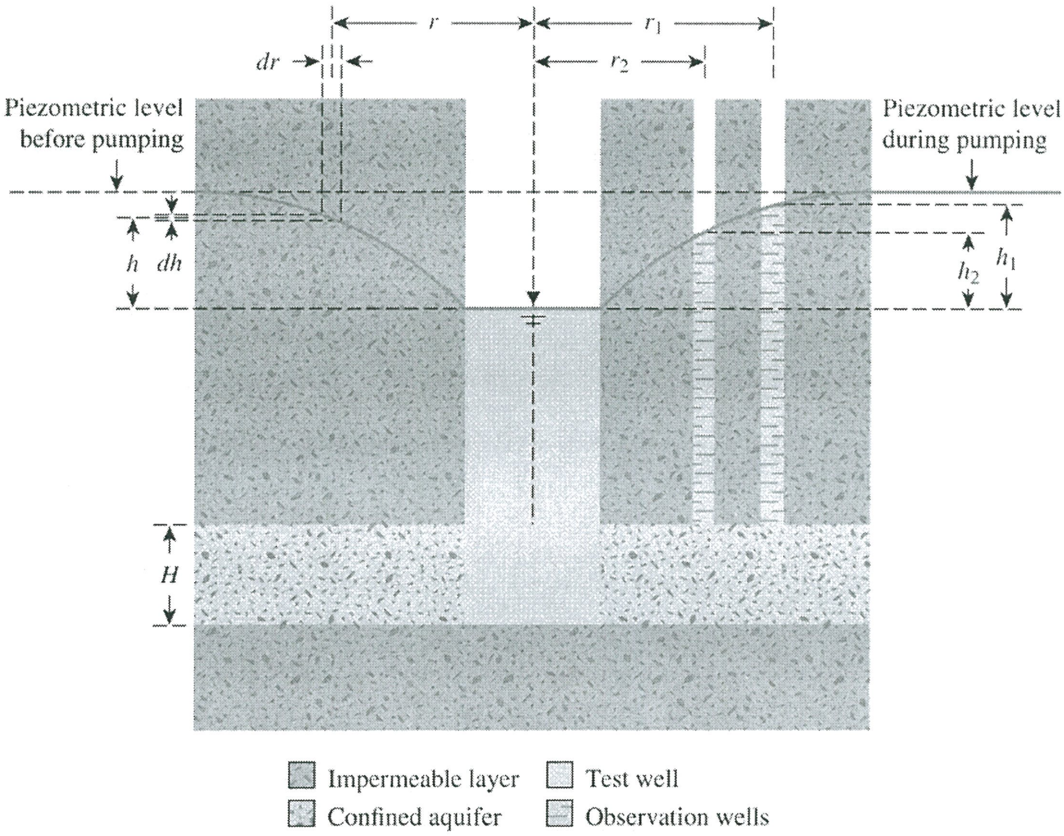

FIGURE B: Pumping test from a well penetrating the full depth in a confined aquifer

$$k = \frac{q \log_{10}\left(\dfrac{r_1}{r_2}\right)}{2.727H(h_1 - h_2)}$$

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$$Cu = \frac{D_{60}}{D_{10}}; \; Cc = \frac{D^2{}_{30}}{D_{10}D_{60}}$$

$$R = \frac{\gamma_{d(field)}}{\gamma_{d(max-lab)}}; \; Dr = \left[\frac{\gamma_{d(field)} - \gamma_{d(min)}}{\gamma_{d(max)} - \gamma_{d(min)}}\right]\left[\frac{\gamma_{d(max)}}{\gamma_{d(field)}}\right]$$

Dry density for plotting Zero air void,

$$\rho_d = \frac{1 - \frac{V_a}{100}}{\frac{1}{\rho_s} + \frac{W}{100_{\rho w}}}$$

where
- ρ_d is the dry density (in Mg/m^3);
- ρ_s is the particle density (in Mg/m^3);
- ρ_w is the density of water (in Mg/m^3), assumed equal to 1;
- V_a is the volume of air voids in the soil, expressed as a percentage of the total volume of the soil (equal to 0 %, 5 %, 10 % for the purpose of this plot);
- w is the moisture content (in %).

Various forms of relationship for γ, γ_d and γ_{sat}

Moist unit weight (γ)		Dry unit weight (γ_d)		Saturated unit weight (γ_{sat})	
Given	Relationship	Given	Relationship	Given	Relationship
w, G_s, e	$\frac{(1+w)G_s\gamma_w}{1+e}$	γ, w	$\frac{\gamma}{1+w}$	G_s, e	$\frac{(G_s+e)\gamma_w}{1+e}$
S, G_s, e	$\frac{(G_s+Se)\gamma_w}{1+e}$	G_s, e	$\frac{G_s\gamma_w}{1+e}$	G_s, n	$[(1-n)G_s+n]\gamma_w$
w, G_s, S	$\frac{(1+w)G_s\gamma_w}{1+\frac{wG_s}{S}}$	G_s, n	$G_s\gamma_w(1-n)$	G_s, w_{sat}	$\left(\frac{1+w_{sat}}{1+w_{sat}G_s}\right)G_s\gamma_w$
w, G_s, n	$G_s\gamma_w(1-n)(1+w)$	G_s, w, S	$\frac{G_s\gamma_w}{1+\left(\frac{wG_s}{S}\right)}$	e, w_{sat}	$\left(\frac{e}{w_{sat}}\right)\left(\frac{1+w_{sat}}{1+e}\right)\gamma_w$
S, G_s, n	$G_s\gamma_w(1-n)+nS\gamma_w$	e, w, S	$\frac{eS\gamma_w}{(1+e)w}$	n, w_{sat}	$n\left(\frac{1+w_{sat}}{w_{sat}}\right)\gamma_w$
		γ_{sat}, e	$\gamma_{sat} - \frac{e\gamma_w}{1+e}$	γ_d, e	$\gamma_d + \left(\frac{e}{1+e}\right)\gamma_w$
		γ_{sat}, n	$\gamma_{sat} - n\gamma_w$	γ_d, n	$\gamma_d + n\gamma_w$
		γ_{sat}, G_s	$\frac{(\gamma_{sat}-\gamma_w)G_s}{(G_s-1)}$	γ_d, G_s	$\left(1-\frac{1}{G_s}\right)\gamma_d + \gamma_w$
				γ_d, w_{sat}	$\gamma_d(1+w_{sat})$